# DESIGN AND PERFORMANCE ASSESSMENT OF A PARABOLIC TROUGH COLLECTOR BY USING ANSYS

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## Abstract

*Parabolic-trough collectors (PTCs) speak to a demonstrated wellspring of warm vitality for modern process warmth and power era; tragically it is as yet not exceedingly executed because of specialized and monetary hindrances. Lately, ecological issues have concentrated consideration on efficient power vitality assets, enhancing the shot for PTCs to be financially aggressive in the market. The Middle East district is viewed as a fascinating territory for actualizing sunlight based vitality ventures since the sun is sparkling the vast majority of the year with high direct irradiance esteems. In this examination, a six meter long illustrative trough gatherer was planned, built and tried to survey its execution. The aftereffect of this work demonstrates the proficiency and capability of such efficient power vitality hotspots for both nearby society and leaders. The mechanical examination of the structure of the trough was recreated both physically and utilizing the limited component programming ANSYS. The trial test concentrated on coordinate steam era, temperature variety with mass stream rate and warm productivity. The most extreme steam temperature measured was 123˚C at a weight of 2 bars, and the greatest productivity acquired was 22.4%.*

***Keywords:*** *Solar Energy; Concentrated Solar Power; Parabolic Trough Collector; Direct Steam Generation.*

## 1.0 INTRODUCTION:

People dependably utilize the beams of the sun to accumulate their vitality needs. Vitality needs of today with increasing environmental concern, elective frameworks to be examined to diminish the utilization of non-inexhaustible and contaminating petroleum products. One such probability is sunlight based vitality, which has turned out to be progressively prominent as of late. Presently a-days sun based vitality has been unequivocally advanced as accessible vitality source. One of the easiest and most direct utilizations of this vitality is the transformation of sunlight based radiation into warm. Thus, the residential segment can diminish its effect on the earth is by the establishment of sun oriented explanatory trough authorities for warming water. In spite of the fact that it ought to be said that some of these authorities have been in benefit for the last 40-50 years with no genuine noteworthy changes in their plan and operational standards. The utilization of sunlight based vitality is focused at show on photovoltaic and warm sun powered vitality transformation frameworks.

In this procedure sun oriented vitality is gotten and exchanged by an authority framework to a working fluid. The most vital ones being biomass and sun powered In perspective of this, further research and usage of non-sustainable power source advancements towards supplementing the traditional wellsprings of vitality ought to be effectively abused as it would be a waste not to completely use the sun oriented vitality that we are honored with. There are numerous concentrative sun powered vitality gathering innovations that have advanced and created. They are the dish concentrator, cone shaped concentrators, the V-trough concentrator, the illustrative trough concentrator and others.

**Figure 1.1 Current and projected world energy use by fuel type.**

| System | Peak Efficiency (%) | Annual Efficiency (%) | Annual Capacity Factor (%) |
|---|---|---|---|
| **Trough/linear Fresnel** | **21** | 10–12 (d) | 24 (d) |
| **Power tower** | **23** | 14–18 (p) | 25–70 (p) |
| **Dish/engine** | **29** | 14–19 (p) | **25 (P)** |

**Parts of a Solar Collector Assembly:**

Sun based collector. Oriented North-South and following the sun from east to west, yet this additionally relies upon the land constraints. The financial practicality of PTC sunlight based plants depends on finding the ideal size for a given electric yield. The preparatory examination is performed by the reconciliation of the complexmodels and parts, which are incorporated to mimic genuine working conditions. This exposition proposes the advancement of a basic approach for the underlying designof allegorical trough universes in view of physical models.

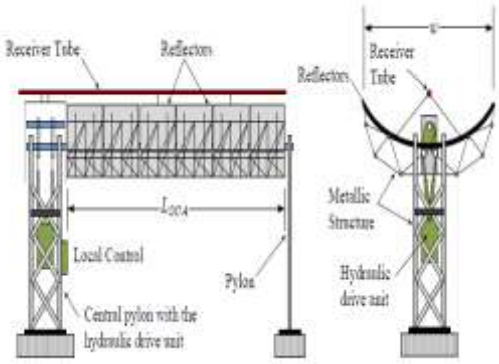


**Figure:**Parts of a Solar Collector Assembly

**Basic theory of solar parabolic trough:**

The guideline of the illustrative trough authority in solar radiation originating from the specific heading is gathered over the range of the reflecting surface and in aggregated at the focus of the parabola, if the reflector is as a trough of a parabolic cross-area, the sun powered radiation is engaged along a line. Barrel shaped allegorical concentrators are utilized as a part of which safeguard is put along center hub. In Parabolic trough collector, the surface zone which retains sun oriented radiations is very small contrasted with the zone presented to the Sun's beams. The cover may be level glass or Fresnel focal point. The sidewalls might be straight or bended as appeared. The tubular recipient conveys the liquid to be heated.

**Materials:**

- Highly polished aluminum sheet as a reflector
- copper tube as a safeguard
- flexible employ as a spine of the reflector
- Plywood for parabolic support and parabolic end.
- stainless steel pipe and copper couplings

**OBJECTIVE:**

The proposed work has the accompanying targets and commitments in the field of explanatory trough sun powered authority framework:

• To propose an approach by which the outline and choice of illustrative trough sun oriented authority framework can be made thorough and simple.

• The above model is to be utilized as a part of displaying and examination for top to bottom investigation of the entire framework.

• Optimization of PTSC framework concerning the execution i.e. warm

effectiveness, gatherer proficiency, quality, liability, sturdiness and in particular the cost of various materials constituting the PTSC framework.

• Complete investigation, assessment, and examination of the distinctive PTSC framework accessible in the worldwide market, and furthermore the positioning and ideal determination of the PTSC framework.

## 2.0 LITERATURE REVIEW:

**[1] Lytvynenko and Schur (1999)**have clarified use of the concentrated sunlight based vitality for process of mis-sharpening of sheet metals. Significance of super plastic shaping (SPF) was explained in this work, most vital part that with the use of the concentrated sun oriented vitality, the operation can be made less complex and less expensive. Missharpening tests were performed for forming with a punch and negative framing. Results demonstrated uniform distortions in every one of the trials. In this manner usage of the concentrated sunlight based vitality for warming amid shaping of sheet metals was supported for the places which are found far from ordinary power sources.

**[2] Kalogirou (2004)** led a study of different sorts of sunlight based warm authorities and their applications and was introduced in his work. At first, an investigation of the ecological problems related to the utilization of ordinary wellsprings of vitality was exhibited and the advantages offered by sustainable power source frameworks were plot. Different sorts of authorities like level plate, compound parabolic, cleared tube, illustrative trough, Fresnel focal point, explanatory dish and heliostat field collectors were clarified. Optical, warm and thermodynamic examination of the authorities and a description of the strategies used to assess their execution were portrayed.

**[3]Makas (2004)** has researched the issue of buildup of steam on a vertical level of even tubes by both logical and exploratory strategies. At first, basics of stream administrations have been examined. A PC program, written in Mathcad, has been executed for the investigation of film buildup. The program was fit to figure condensate film thickness and speed appropriation, and also the warmth exchange coefficient inside the condensate. An exploratory setup was likewise created to watch the buildup marvel. Impacts of tube distance across and temperature distinction amongst steam and the tube divider on buildup warm exchange were diagnostically explored with a PC program.

**[4] Mohamed et al. (2012)** planned and created sun powered dish concentrator with 1.6 meters diameterfor water warming application and for era of steam. The dish was manufactured utilizing excited steel and its inside surface was secured with a reflecting layer of reflectivity up to 76%. The framework was furnished with a beneficiary (heater) situated in the central position. The warmth beneficiary was made of stainless steel round and hollow tube, covered with a thin layer of dark paint as antireflection covering and was situated in the central zone of the sunlight based dish concentrator. Water warming was finished by going water through helical wrapped copper tubes inside the collector cavity.

## 3.0 METHODOLOGY:

The reproduction strategies were deliberately created andthe strategy for the

procedure configuration is as appeared in Fig. After the underlying outline parameters are settled, the parabolic equation, point of convergence and edge is gotten. By utilizing a preset esteem for the CR, the measurement dRof the recipient is calculated utilizing (1). Next, the full plan determinations are processed to characterize the model. The parameters are the overall heat misfortune coefficient UL, convective warmth exchange coefficient and warm evacuation factor. The handled sun oriented insulation data consists of the pillar radiation I band diffuse radiation Id. Rband Rd are the proportion of the aggregate radiation on a tilted surface tothat on the even surface for shaft and diffuse radiations respectively. Utilizing these qualities, the ingested sunlight based radiation S is figured and utilized as a part of the vitality condition.

**STRESS ANALYSIS:**

A mechanical investigation of the trough was done, this was imperative to anticipate if mechanical disappointment may happen in any of the parts.

As specified, the impact of twist on the trough is an essential factor that must be examined. The power delivered by twist on the trough can be ascertained by the non specific equation for real breeze speed:

$$F = APC_d$$

where:

P is the wind dynamic pressure,

A is the projected area

$C_d$ is the drag coefficient

$$F_{wind} = (0.5 \times 1.19 \times 7^2)(1.6 \times 6)(1.6$$

And per unit length

$$F_{wind} = 450/6 = 75N/m$$

The heaviness of the trough will likewise have a circulated stack impact (270 N/m) on the trough as appeared in figures 1 and 2, those two figures demonstrate the activity and response powers following up on the trough, notwithstanding shear power and twisting minute chart.

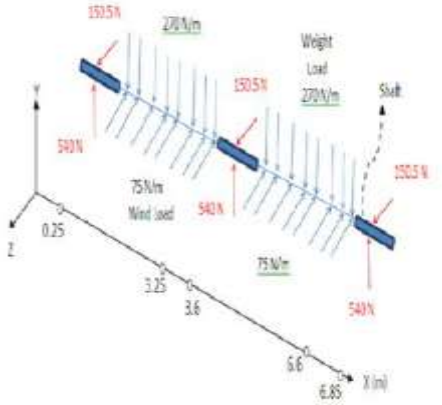


**FIG: The action and reaction forces acting on the trough.**

Utilizing fitting programming, the above limit and stacking conditions were acquainted with acquire the distortion and most extreme suitable worry as appeared in Figures The got comes about demonstrated that the stacking conditions are inside the versatile furthest reaches of the total structure.

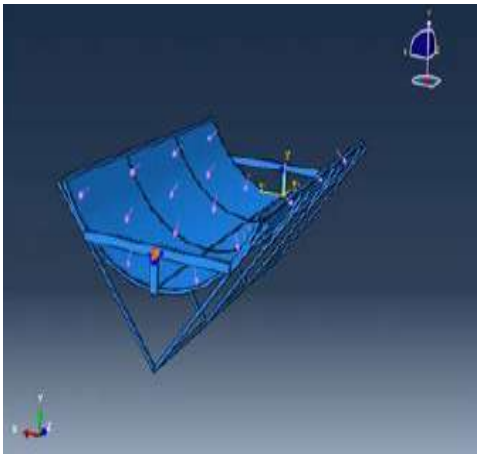

**Figure: Loading conditions of the PTC.**

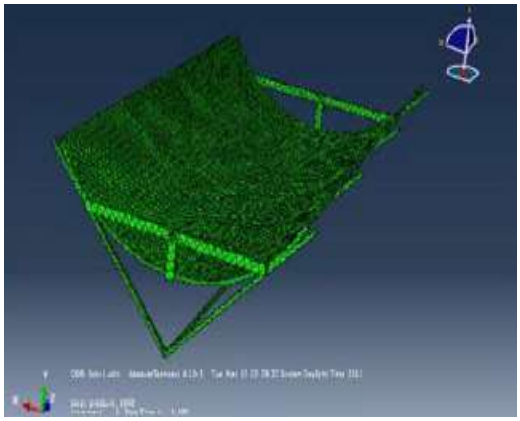

**Figure: The equivalent Von-Mises stresses.**

## Description of PTSC plant based on DSG:

A PTC is fundamentally comprised of an allegorical trough-molded mirror that reflects coordinate sun oriented radiation, concentrating it onto a recipient tube situated in the central line of the parabola. Centralization of the direct sun oriented radiation decreases the safeguard surface zone regarding the authority opening territory and consequently fundamentally lessens the general warm misfortunes. The concentrated radiation warms the liquid that circles through the recipient tube, hence changing the sun based radiation into warm vitality as the sensible warmth of the liquid.

**PTC COMPONENTS**

| | | |
|---|---|---|
| Outlet water tank | 12 | Pulley |
| Pressure gauge | 14 | Connection shaft |
| Thermocouple | 15 | Receiver holders |
| Outlet pipe | 16 | Rope |
| Outlet valve | 17 | Space frame structure |
| Thermocouple wire inlet to pipe | 18 | End shaft |
| Pressure relief valve | 19 | Inlet valve |
| Absorber pipe | 20 | Inlet pipe |
| Reflecting material | 21 | Pillow block bearing |

## 4.0 RESULTS:

### Parabolic collector analysis:

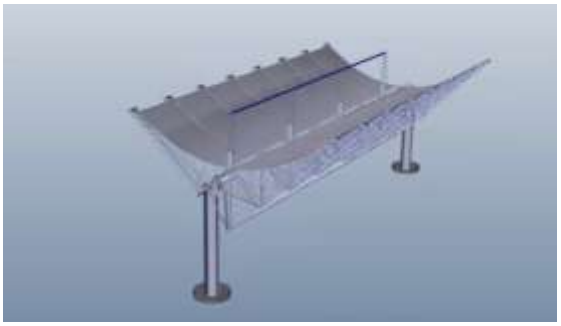

**Figure:**Basic view of the parabolic collector.

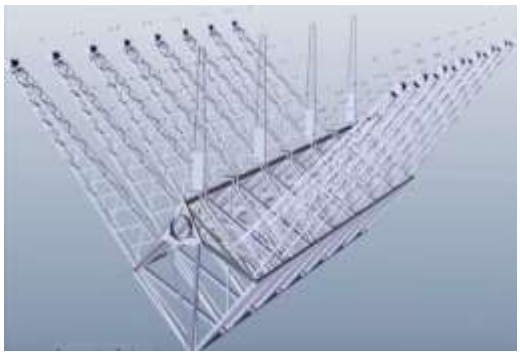

**Figure:**Suspension springs.

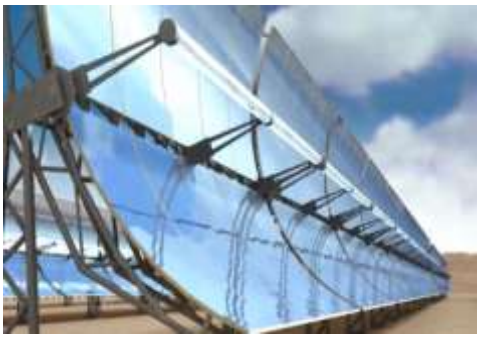

**Figure:** Parabolic through design

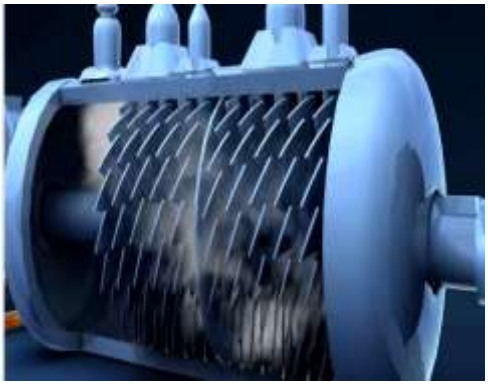

**Figure:**Power plant generates enough electricity

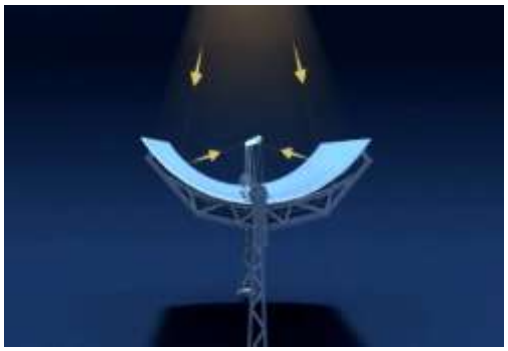

**Figure:**Mirrors would trace sun light

**Figure:** Mirrors would trace side view sun light

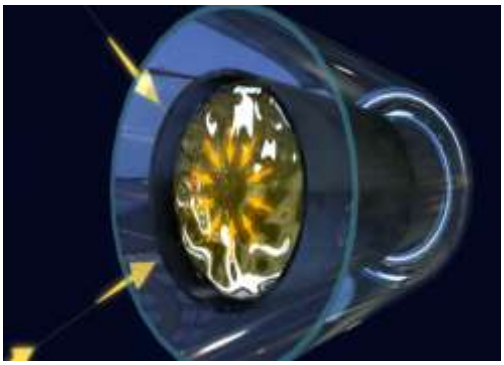

**Figure:** Vacuum layers prevent heat losses

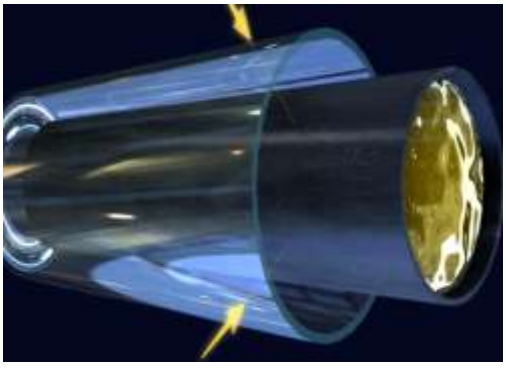

**Figure:**reflected sun light focuses

## Analysis of surface with a Nano particle flow:

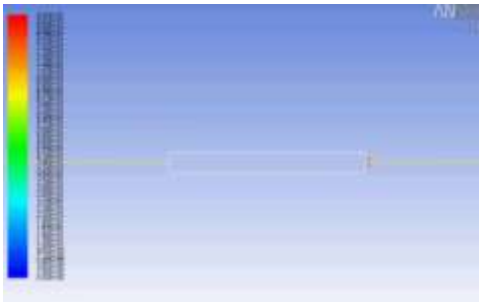

**Figure:**minimum velocity of flow rate

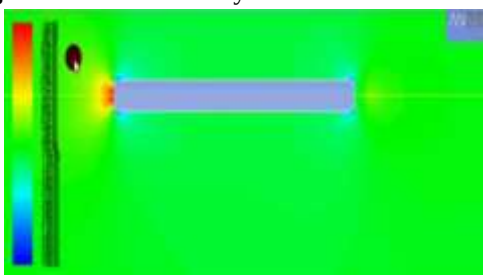

**Figure**: surface friction coefficient

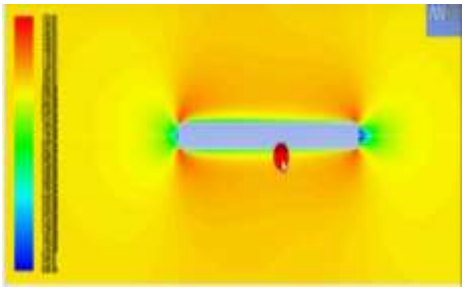

**Figure:**complete distribution of Nano fluid

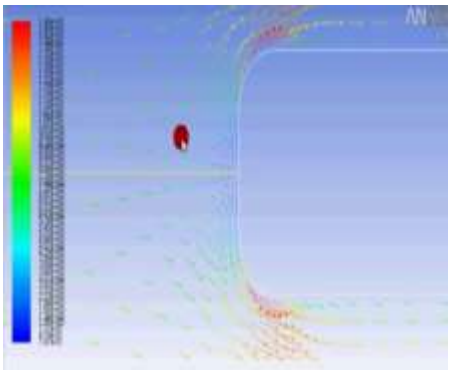

**Figure:** high over rate

**TABLE FLUID FLOWS MAXIMUM AND MINIMUM VALUES**

| PARAMETERS | MAXIMUM VALUE | MINIMUM VALUE |
|---|---|---|
| SHEAR STRESS | 2.50E+00 | 0.00+00 |
| FRICTION COEFFICIENT | 4.50E+00 | 0.00+00 |

**Overall heat transfer coefficient:**

The general warmth misfortune coefficient can be figured by condition and afterward we locate the convective warmth exchange coefficient for standard pipe stream condition forward estimation distinctive sort of number by observational condition for evaluation of inside stream liquid warmth exchange coefficient from condition next discover the authority proficiency factor from and for the computation of warmth evacuation factor we should utilized Foremost vital information zone of sun powered field utilized a similar condition

Productivity and vitality consequences of authority

Info sun based radiation vitality = 4.257MW

Yield of the plant = 1.000 MW

Add up to vitality misfortune from the framework = 3.257 MW

% loss of vitality from the framework =76.52

Authority proficiency = 71.05 %

General plant/authority/sun based field proficiency =23.48%

**5.0 CONCLUSIONS:**

This paper has featured the procedures that are necessary to assess the execution of a CPTC and to utilize the processed information to outline a model by reenactment utilizing real meteorological information of areas in INDIA. By considering the optical elements and warm investigation, the outcomes clearly showed that there must be a harmony accomplished between the expanding warm misfortunes because of the expanding aperture area, with the expanding optical misfortunes due to the decreasing aperture region. The examination found that a focus proportion of 10and the collector's width of 0.03 m are the optimum parameters for the most elevated productivity of the model. In this we have additionally improved the situation the NANO liquid investigation for the allegorical plate where the base 32.68e4 m/s and most extreme stream rate of 64.96e4 m/s are acquired for the stream.

**References**:

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