PERFORMANCE ANALYSIS ON CONCENTRATING COLLECTOR USING DUAL AXIS SOLAR TRACKING MECHANISM

PROJECT MEMBERS:

1.	Jignesh Amin	Roll No.:D12me19	Enroll No.:120783119018
2.	Keyur Patel	Roll No.:10me35	Enroll No.:100780119055
3.	Sanket patel	Roll No.:10me58	Enroll No.:100780119048
4.	Umang Prajapati	Roll No.:11me76	Enroll No.:110780119082

GROUP NO.:- 7 **GROUP ID.:- 24258**

Under Guidance of : Prof. R.N.MEVADA

Department of Mechanical engineering,
Smt. S. R. Patel Engineering College,
Dabhi,Unjha-384170

CONTENTS

INTRODUCTION

- A **solar tracker** is a device that orients a payload toward the sun. Pay loads can be photovoltaic panels, reflectors, lenses or other optical devices.
- Sunlight has two components, the "direct beam" that carries about 90% of the solar energy, and the "diffuse sunlight" that carries the remainder - the diffuse portion is the blue sky on a clear day and increases proportionately on cloudy days.
- As the majority of the energy is in the direct beam, maximizing collection requires the sun to be visible to the panels as long as possible.

- Concentrating, or focusing, collectors intercept direct radiation over a large area and focus it onto a small absorber area.
- These collectors can provide high temperatures more efficiently than flat-plate collectors, since the absorption surface area is much smaller. However, diffused sky radiation cannot be focused onto the absorber.
- Most concentrating collectors require mechanical equipment that constantly orients the collectors toward the sun and keeps the absorber at the point of focus.

LETERATURE REVIEW

NO.	AUTHOR	TITLE	REMARK
1.	**Saad D. Odeh et. all**	**Design and development of an educational solar tracking parabolic trough collector system**	•Renewable energy sources and systems have become popular topics of study for thermal engineering students. This article presents the design, development, testing and evaluation of an educational single-axis solar tracking parabolic trough collector that represents a standalone system to produce process heat at a moderate temperature for instructional and demonstrative purposes. • The parabolic trough solar collector consists of a stainless steel parabolic reflector, a flat solar receiver, a thermal storage tank and a closed loop tracking system. •The tracking system comprises electro-mechanical components such as a control box, a DC motor, a photo sensor and a gear box.

NO.	AUTHOR	TITLE	REMARK
2.	Mansi G. Sheth et all	**DESIGN AND DEVELOP-MENT OF COMPOUND PARABOLIC CONCENT-RATING SOLAR COLLECTOR WITH FLAT PLATE ABSORBER**	•The design and development of 2-dimensional non-imaging type CPC with flat plate absorber and having two parabolic reflectors is attempted. It seems to be far better than flat plate collector and the focusing type collector like simple parabolic concentrator.

NO.	AUTHOR	TITLE	REMARK
3.	Jeff Muhs et all	**DESIGN AND ANALYSIS OF HYBRID SOLAR LIGHTING AND FULL-SPECTRUM SOLAR ENERGY SYSTEMS**	•This paper describes a systems-level design and analysis of a new approach for improving the energy efficiency and affordability of solar energy in buildings, namely, hybrid solar lighting and full-spectrum solar energy systems. •By using different portions of the solar spectrum simultaneously for multiple end-use applications in buildings, the proposed system offers unique advantages over other alternatives for using sunlight to displace electricity.

NO.	AUTHOR	TITLE	REMARK
4.	Vanita Thakkar et all	**Status of Parabolic Dish Solar Concentrators**	•Concentrated Solar Power (CSP) Technology promises solutions to several problems in the present Energy Crisis and Global warming. Parabolic Dish Solar Concentrators have shown high conversion efficiencies and operating temperatures (around 750oC at annual efficiency of 23%-29% peak). Research is on, with some prototypes tested world-wide. • Dish Engine Technology has high investment costs, almost twice as those for parabolic troughs. Dish Engine system industries and initiatives are mostly confined to the US and Europe.

NO.	AUTHOR	TITLE	REMARK
5.	IBRAHIM LADAN MOHAMMED	**DESIGN AND DEVELOPMENT OF A PARABOLIC DISH SOLAR WATER HEATER**	•The design and development of a parabolic dish solar water heater for domestic hot water application (up to 100oC) is described. The heater is to provide 40 litres of hot water a day for a family of four, assuming that each member of the family requires 10 litres of hot water per day. For effective performance the design requires that the solar water heater track the sun continuously, and an automatic electronic control circuit was designed and developed for this purpose. Experimental test runs carried out showed that the overall performance of the solar water heater was satisfactory. • Thermal efficiencies of 52% - 56% were obtained, and this range of efficiencies is higher than the designed value of 50%. The use of a linear actuator (Superjack) to track the sun eliminates the need for constant monitoring by a human operator and, thus, reduces the cost of labour.

NO.	AUTHOR	TITLE	REMARK
6.	Ram Bhool et all	**PERFORMANCE EVALUATION AND REGENERATION OF ACTIVATED CHARCOAL BY SOLAR PARABOLIC DISH COLLECTOR**	• Recent years public interest in issue related to concern for the environment and energy saving. Due to the problem creating with the use of alternative source of energy, fossil fuel has become important and relevant in this competition. These sources, such as ocean wave, the sun, wind, can never be exhausted and are called renewable energy source. They also have known as non convectional sources of energy because it cause very less pollution and are available locally. • It is commonly assumed that dish type solar pressure cooker save energy and make a nutrient rich food. The energy concentration of dish solar collector has rarely been analyzed including their embodied energy.

NO.	AUTHOR	TITLE	REMARK
7.	Vijay Talekar et all	**Performance Improvement of Solar PV Panel Using Reflectors and Bi-Axial Tilting Mechanism**	•The purpose of the proposed paper is to implement Bi-Axial system with collector effectively. The designed tracker for sun rays is found worked efficiently. The bi-axial tracking system was found effective than single axis tilting mechanism. Due to use of collector on the panel the performance of the panel is doubled. • The extracted power was found increased significantly by using Bi-Axial tilting Mechanism. The same mechanism can be used for solar apparatus like oven, cooker, heaters, etc.

NO.	AUTHOR	TITLE	REMARK
8.	Yong Kim et all	**An evaluation on thermal performance of CPC solar collector**	•The main objective of this work is the investigation and improvement of thermal performance of evacuated CPC(Compound Parabolic Concentrator) solar collector with a cylindrical absorber. Modified types of this solar collector are always combined with the evacuated glass envelop or tracking system. •The conventional stationary CPC solar collector has been compared with the single axis tracking CPC solar collector in outlet temperature, net heat flux onto the absorber and thermal efficiency. Numerical model has been analyzed based on the irradiation determined actually and the results have been calculated to predict the thermal efficiency. • The result shows the thermal efficiency of the tracking CPC solar collector is more stable and about 14.9% higher than that of the stationary CPC solar collector.

NO.	AUTHOR	TITLE	REMARK
9.	Pradeep Kumar K V et all	**Design, Fabrication and Experimental Testing of Solar Parabolic Trough Collectors with Automated Tracking Mechanism**	•This research has its own special features. it is satisfactory considering the market survey report. The use of solar troughs is limited only to clear sunny days. The Solar trough tilting angle is limited to a maximum of 120°. The steam can produce scaling inside the metal absorber pipe and hence, non-corrosive coating should be applied in it. The Tracking Mechanism is of single Axis (North South horizontal). Additional maintenance is required to clean the dirt absorbed on the glass surface. •The solar concentrating collector is among the best way to use solar energy efficiently due to its advantages to convert abundantly available solar energy into effective and convenient form of heat energy which can be used for various purposes.

NO.	AUTHOR	TITLE	REMARK
10.	Adolfo Ruelas et all	**Design, Implementation and Evaluation of a Solar Tracking System Based on a Video Processing Sensor**	• The amount of solar energy captured by a sun collector determines the output power generated for thermal or photovoltaic applications. Hence, accurate solar tracking systems have an important role in the performance of solar collecting technologies. • In this article the design, implementation and evaluation of a compact two-axes solar tracking system is presented. •The system consists of a video processing based sensor connected to a microcontroller that computes a sun-positioning algorithm. The developed structure, by eliminating expensive computing systems, allows closed loop solar tracking as simple, low cost with minimal configuration. The evaluation results show solar tracking average accuracy of 0.0135 degrees for the azimuth angle and 0.0196 degrees for the zenith angle.

METHODOLOGY

Project title

Study about solar tracking mechanism.

Searching the research papers

Study the research papers and other introductory topics

Study and analysis of flat plate collector tracking mechanism

Study and analysis of single axis concentrating plate collector tracking mechanism

Study and analysis of double axis concentrating plate collector tracking mechanism

Comparison between concentrating and flat plate collector in terms of performance

Conclusion

WORK PLANNING

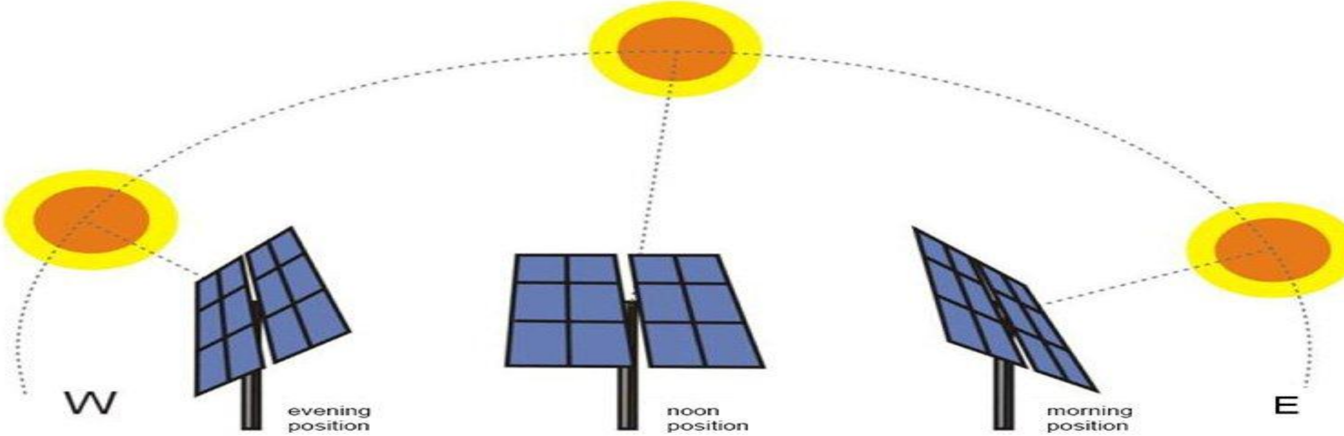
MONTH	WORK SEQUENCE
1. JULY	1. Define problem 2. Study of problem 3. Study in flat plate single axis solar tracking mechanism
2. AUGUST	1. Study in concentrating plate solar tracking mechanism 2. Select the concentrating plate collector in dual axis solar tracking mechanism

MONTH	WORK SEQUENCE
3.SEPTEMBER	1. Introduction of concentrating plate 2. Find of research papers 3. Study of research papers 4. Literature review
4.OCTOMBER	1. Literature review 2. Study different types of components to use in flat plate single axis collector solar tracking mechanism 3. To get reading on flat plate single axis collector solar tracking mechanism and generate result graph 4. To continue project in next semester…..

MONTH	WORK SEQUENCE
5. JANUARY	1. Collect the components of the concentrating solar plat collector. 2. Fill up the pattern.
6.FEBRUARY	1. Design of concentrating collector using dual axis solar tracking mechanism

MONTH	WORK SEQUENCE
7.MARCH	1. Mechanism work 2. Assembly model. 3. To get reading on concentrating plate single axis collector solar tracking mechanism
8.APRIL	1. To get reading on concentrating plate double axis collector solar tracking mechanism 2. Result table and generate the graph of CPC double axis 3. Conclusion

FLATE PLATE SINGLE AXIS TRACKER



- Single axis trackers have one degree of freedom that acts as an axis of rotation. The axis of rotation of single axis trackers is typically aligned along a true North meridian. It is possible to align them in any cardinal direction with advanced tracking algorithms.
- There are several common implementations of single axis trackers. These include horizontal single axis trackers(HSAT),vertical single axis trackers(VSAT),tilted single axis trackers (TSAT) and polar aligned single axis trackers (PSAT). The orientation of the module with respect to the tracker axis is important when modeling performance.

SPECIFICATION

NO	SPECIFICATION	Flat plate collector
1	Dimensions	1.1m x 0.32m x 0.22m
2	Length of the absorber plate	0.95m
3	Width of the absorber plate	0.26m
4	Material of the absorber plate	Copper
5	Thermal conductivity of the plate material	401W/m K
6	Density of the plate material	8960kg/m3
7	Plate thickness	0.00005m
8	flow rate	5 l/hr

OBSERVATION TABLE

NO	Time	(W/m2)	Water temperature of flat plate collector	
			Inlet(°C)	Outlet(°C)
1	12:00 PM	710	32	41
2	12:30 PM	721	33	42
3	1:00 PM	730	36	46
4	1:30 PM	719	35	46
5	2:00 PM	748	37	48
6	2:30 PM	751	35	48
7	3:00 PM	791	34	45
8	3:30 PM	741	36	45
9	4:00 PM	721	37	43
10	4:30 PM	715	34	43

CALCULATION

- Average Solar radiation received by earth in terms of energy R= 722 W/m2/Hr.
- Solar radiation received by earth in 1 hours in terms of energy R = 722*1 W/m2/day.
- where,
- A = Area of Flat plate collector in m2,
- T1 = Temperature of water at inlet in ºC,
- T2 = Temperature of water at outlet in ºC,
- Mass of water taken in the storage tank = 5 Lit
- Specific heat of water Cp = 4.182 kJ/kg K
- R = 722 Wh/m2, R = 1949400 W Sec/m2

- Area of the flat plate collector

  $A = L*W\ m^2 = 0.95*0.26 = 0.266\ m^2$
- Radiation received by collector

  $R1 = R*A = 1949400*0.266 = 518540$ Joules
- Output of the flat plate Collector

  $Q = M*Cp*(T2 - T1)$
- Efficiency of flat plate collector

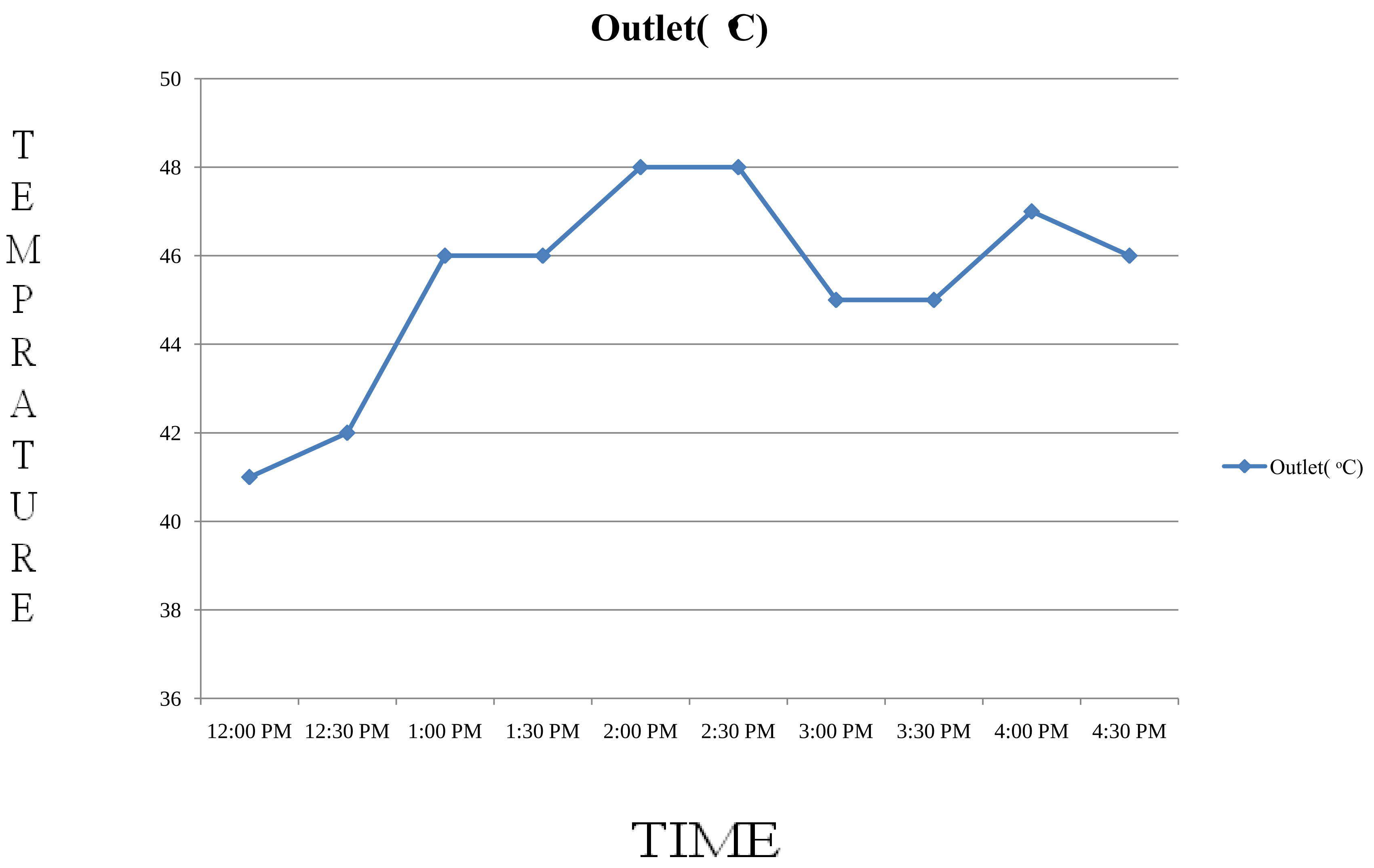
  = Output of the collector / Input Radiation

  $= M*Cp*(T2 - T1) / R*A$

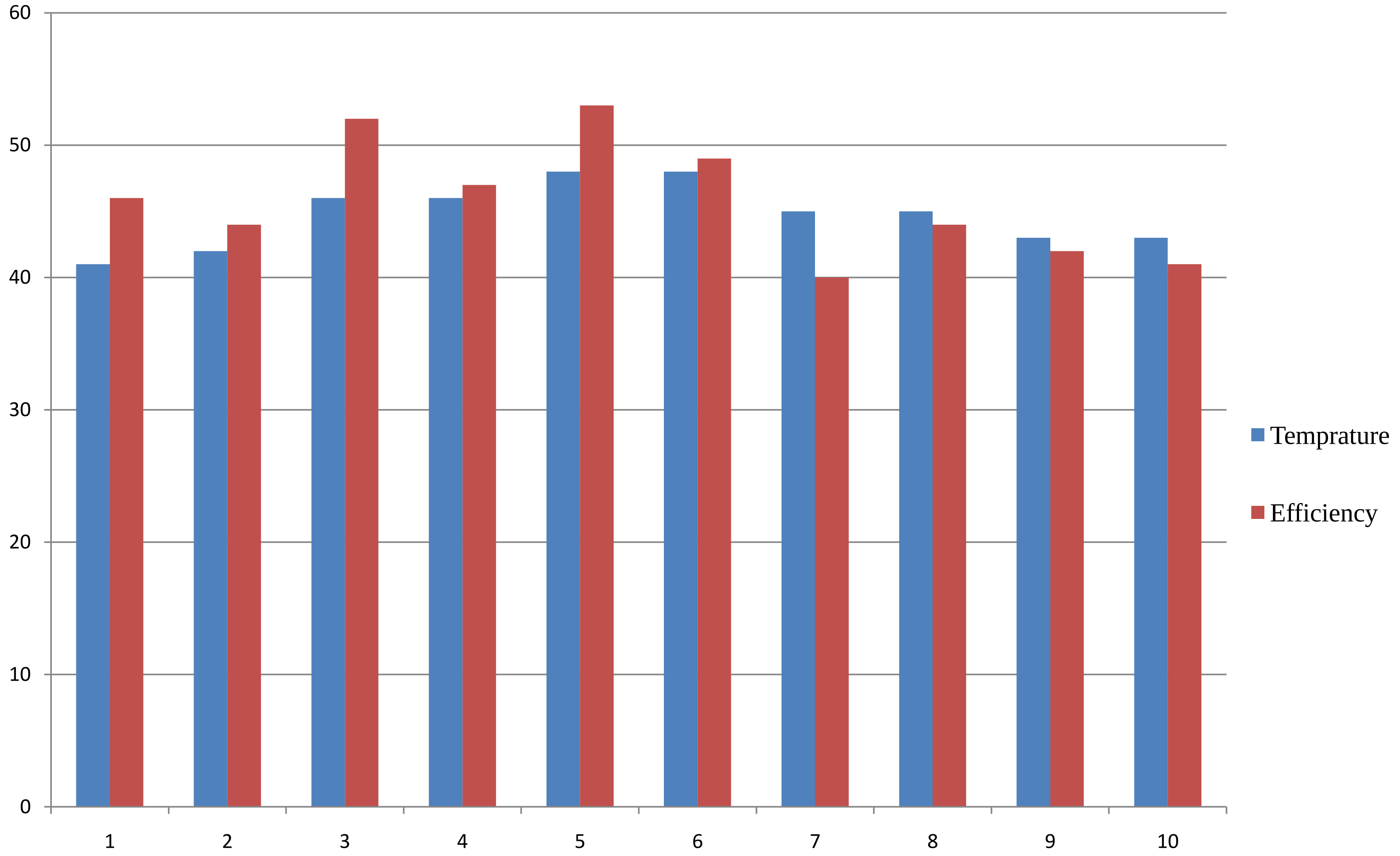
RESULT TABLE

N0	Output of the flat plate Collector(Q) (Joules)	Efficiency of flat plate collector (η)
1	188190	0.3629
2	188190	0.3629
3	209100	0.4032
4	230010	0.4435
5	230010	0.4435
6	271830	0.5242
7	230010	0.4435
8	188190	0.3629
9	209100	0.3028
10	230010	0.4435
	Avg. Q = 221646	Avg. η = 0.40929

Water outlet temperature Vs Time Graph



Temp. Vs Efficiency(%) Graph



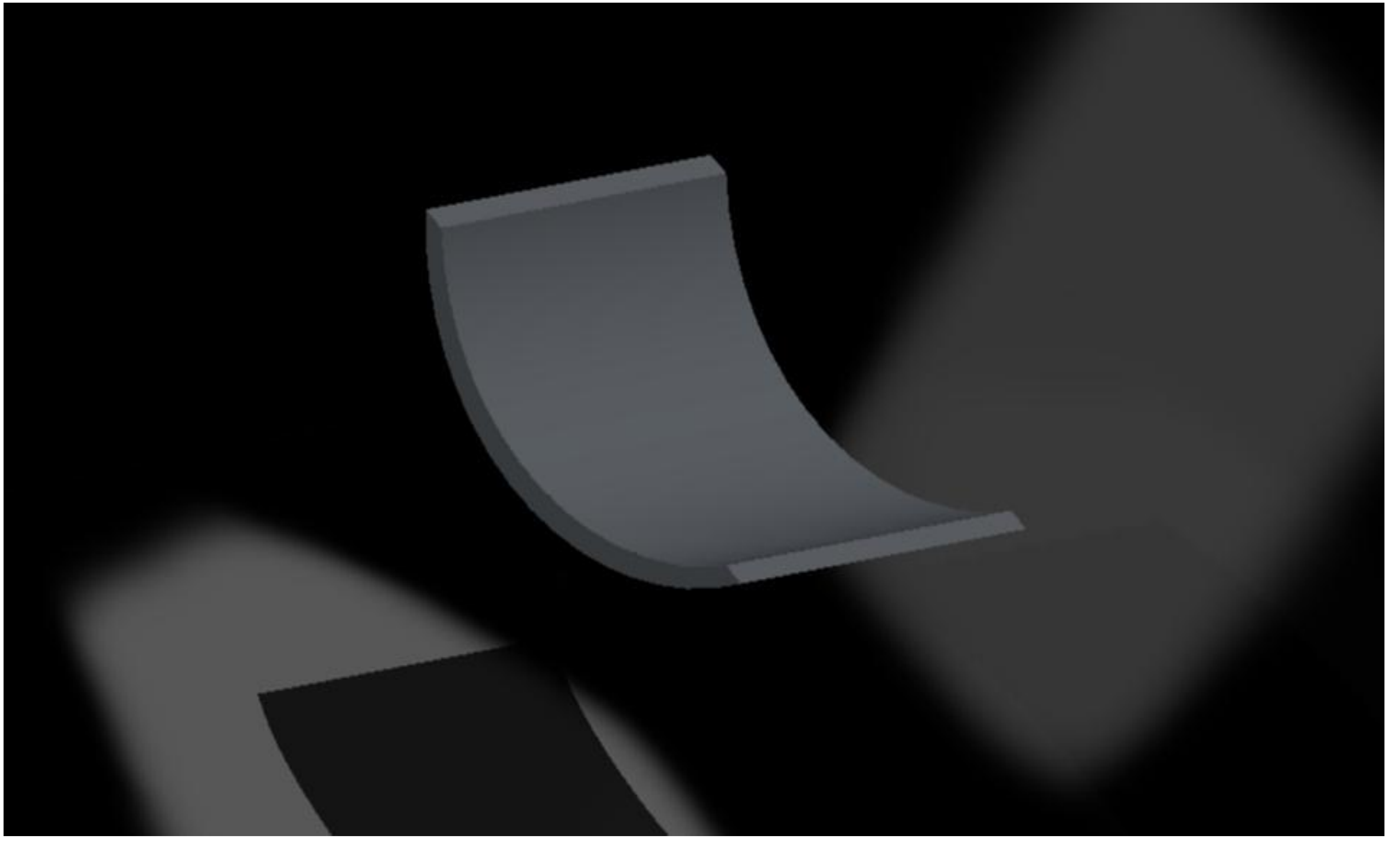
INTRODUCTION OF CONCENTRATING COLLECTOR USING DUAL AXIS SOLAR TRACKING MECHANISM

- Dual axis trackers have two degrees of freedom that act as axes of rotation. These axes are typically normal to one another. The axis that is fixed with respect to the ground can be considered a primary axis. The axis that is referenced to the primary axis can be considered a secondary axis.
- Concentrating, or focusing, collectors intercept direct radiation over a large area and focus it onto a small absorber area. These collectors can provide high temperatures more efficiently than flat-plate collectors, since the absorption surface area is much smaller. However, diffused sky radiation cannot be focused onto the absorber. Most concentrating collectors require mechanical equipment that constantly orients the collectors toward the sun and keeps the absorber at the point of focus.

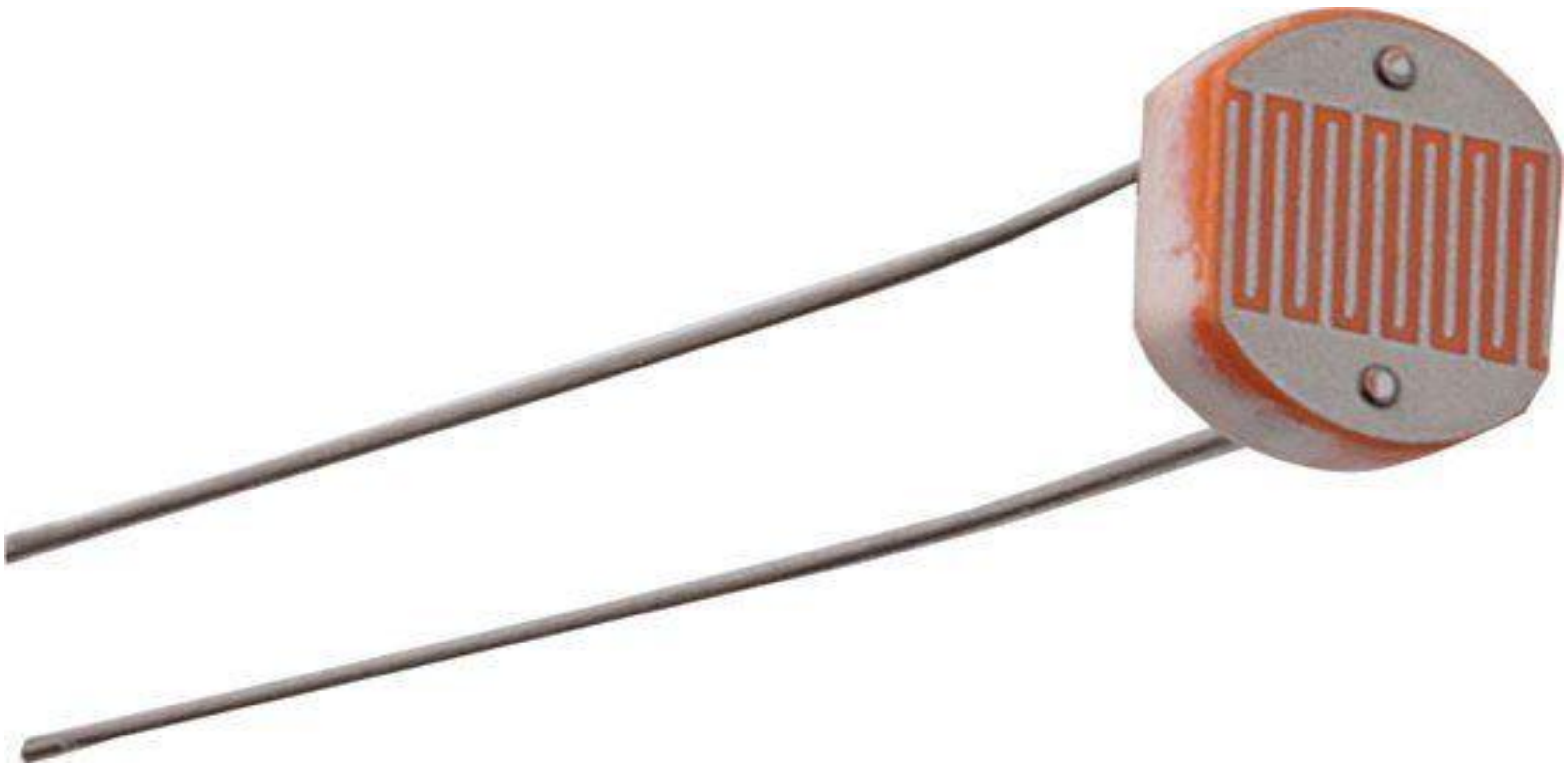
COMPONENTS OF CPC DUAL AXIS

1. CONCENTRATING COLLECTOR
2. SENSOR
3. DC MOTOR
4. THERMOCOUPLE
5. CIRCUIT
6. L- CLAMP & C-CLAMP

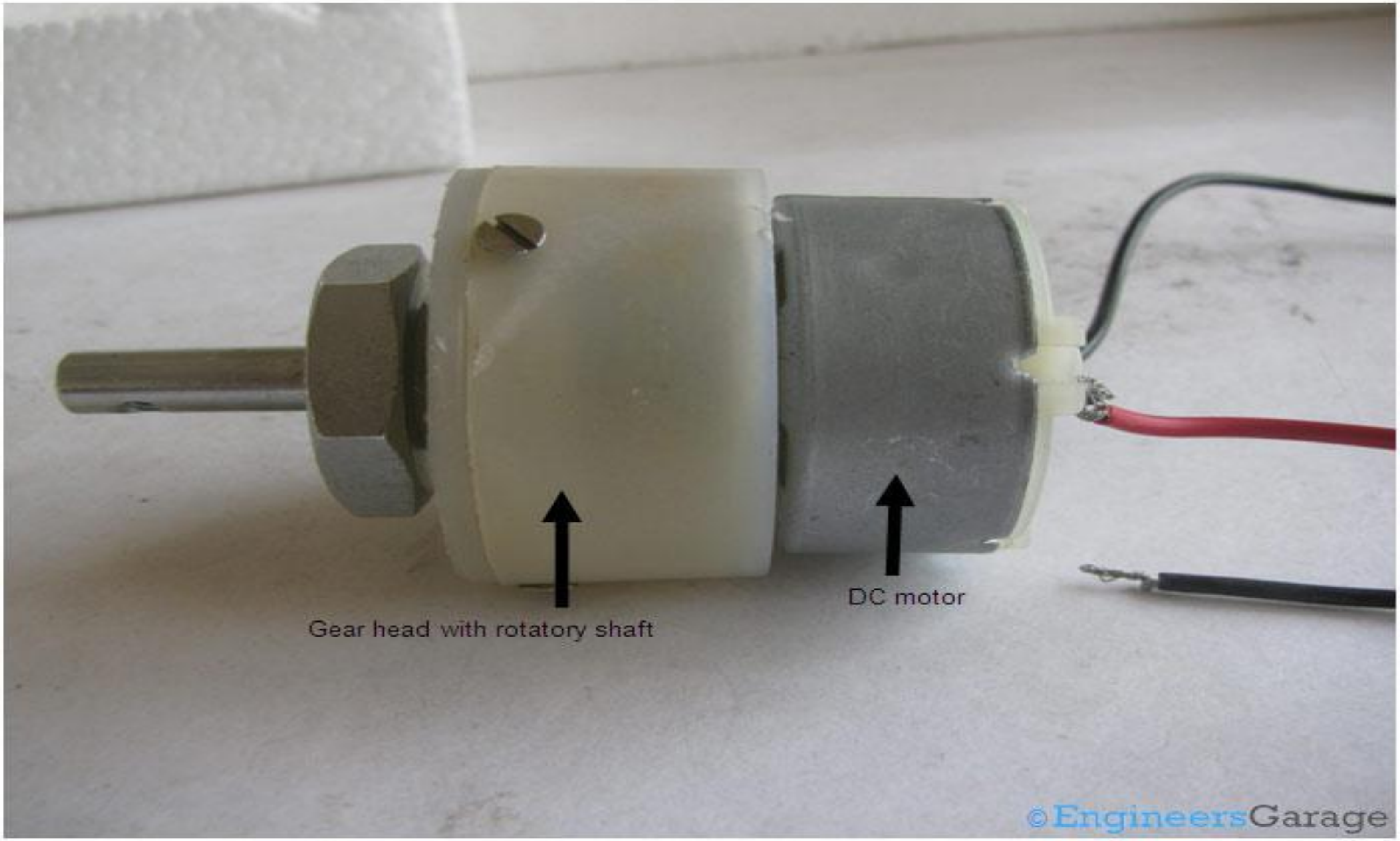
1.CONCENTRATING COLLECTOR



2. SENSOR

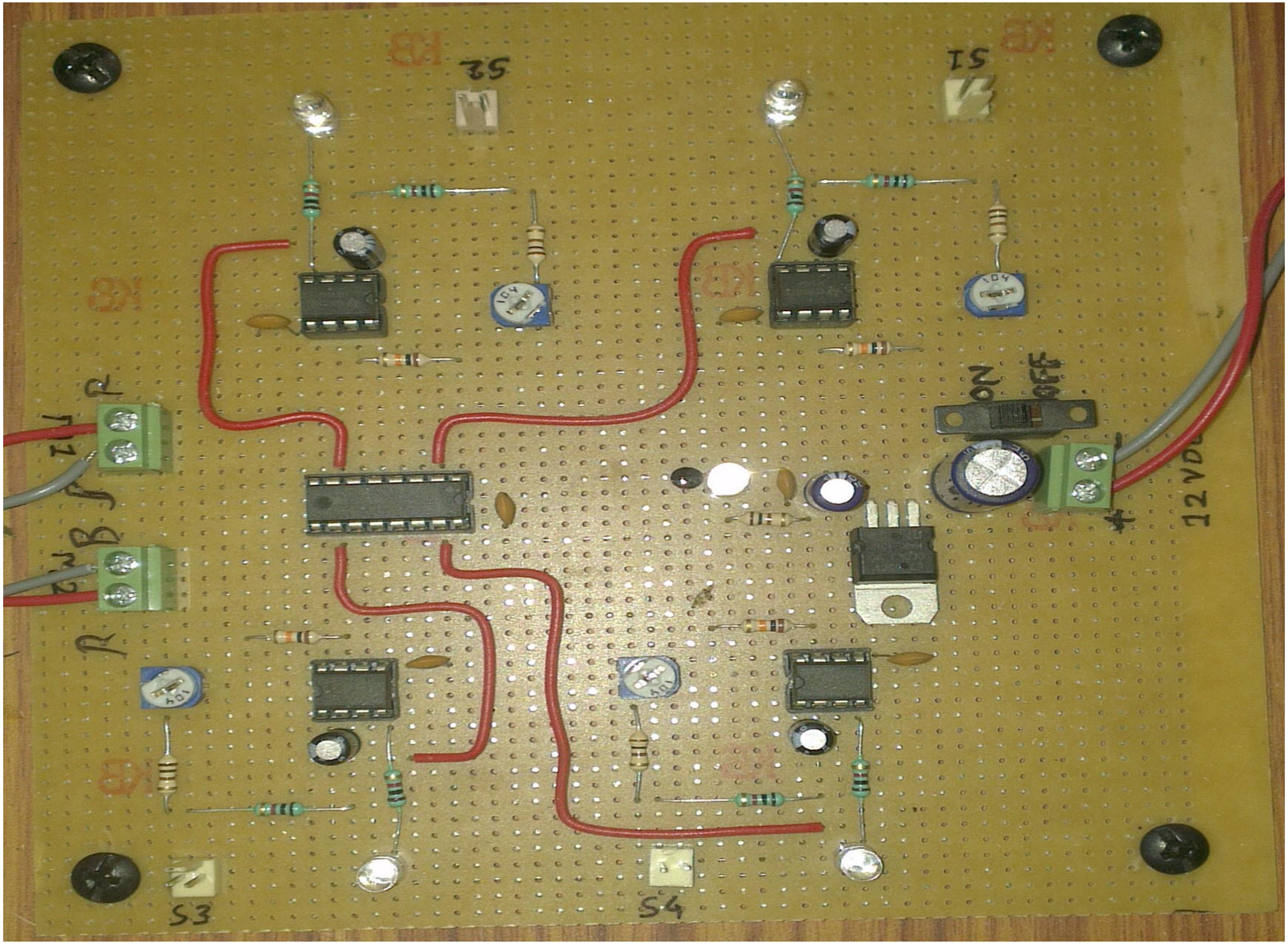


3. DC MOTORS

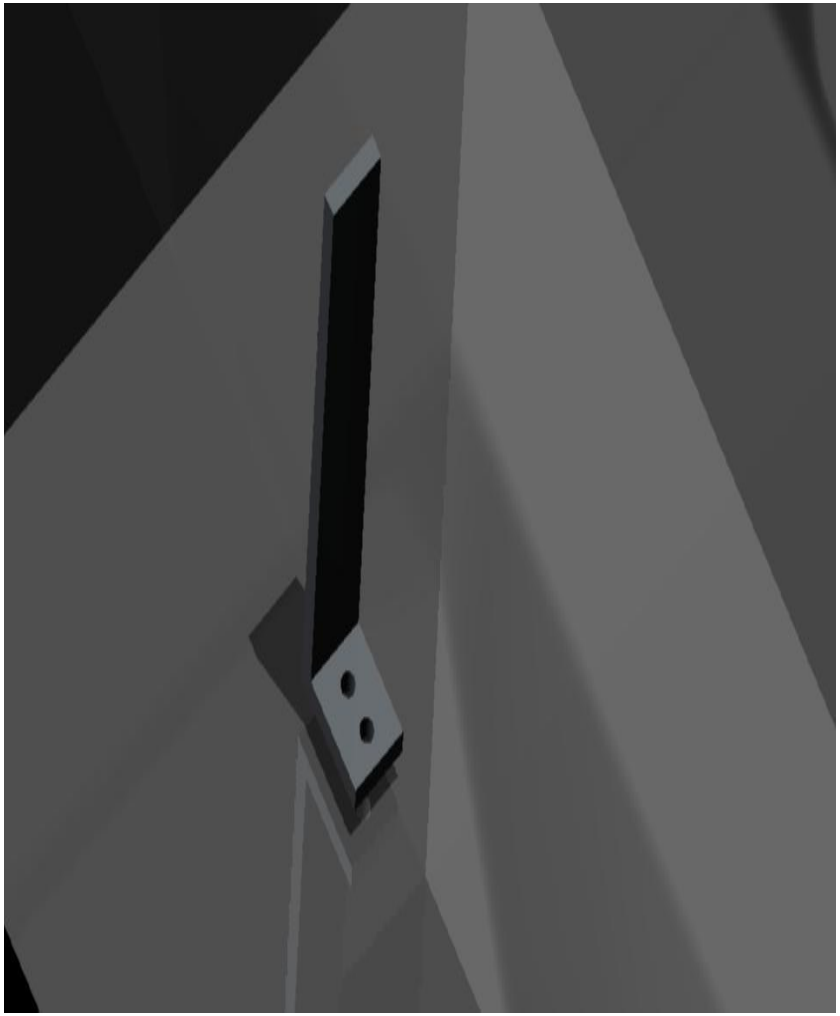


4. THERMOCOUPLE

5. CIRCUIT



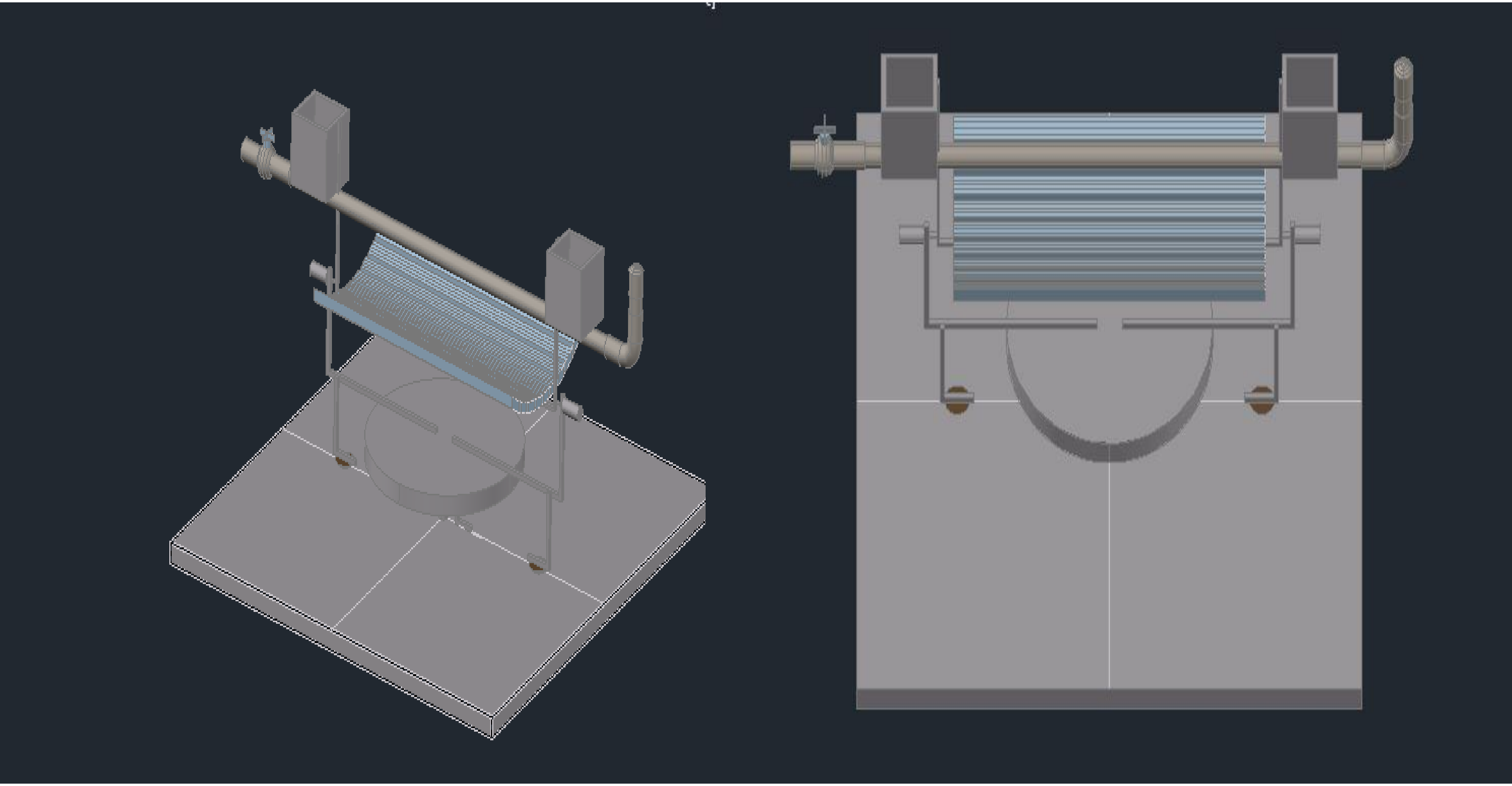
•L-CLAMP:-



C-CLAMP:-

DRAWING OF MODEL

- PLAN.dwg



ASSEMBLY OF MODEL

WORKING MODEL

SPECIFICATION

NO	SPECIFICATION	Flat plate collector
1	Dimensions	0.38m x 0.32m x 0.1m
2	Length of the absorber plate	0.35m
3	Width of the absorber plate	0.1m
4	Material of the absorber plate	Glass
5	Thermal conductivity of the plate material	1.1W/m K
6	Density of the plate material	1644.74kg/m3
7	Plate angle	60^o
8	Plate thickness	0.001m
9	flow rate	2.5 l/hr

CALCULATIONS

- Average Solar radiation received by earth in terms of energy R= 722 W/m2/Hr.
- where,
- A = Area of concentrating plate collector in m2,
- T1 = Temperature of water at inlet in ºC,
- T2 = Temperature of water at outlet in ºC,
- Mass of water taken in the storage tank = 2.5 Lit
- Specific heat of water Cp = 4.182 kJ/kg K
- R = 722 Wh/m2, R = 1949400 W Sec/m2
- Rb = tilt factor for beam radiation = 1.123

- Area of the concentrating plate collector

  A = L*W m2 = 0.70*0.20 = 0.14 m2

- Radiation received by collector

  R1 = R*A = 2664000*0.14= 372960 Joules

- Output of the concentrating plate Collector

  Q = M*Cp*(T2 – T1)

- Efficiency of concentrating plate collector

  = Output of the collector / Input Radiation

  = M*Cp*(T2 – T1) / R1*A*Rb

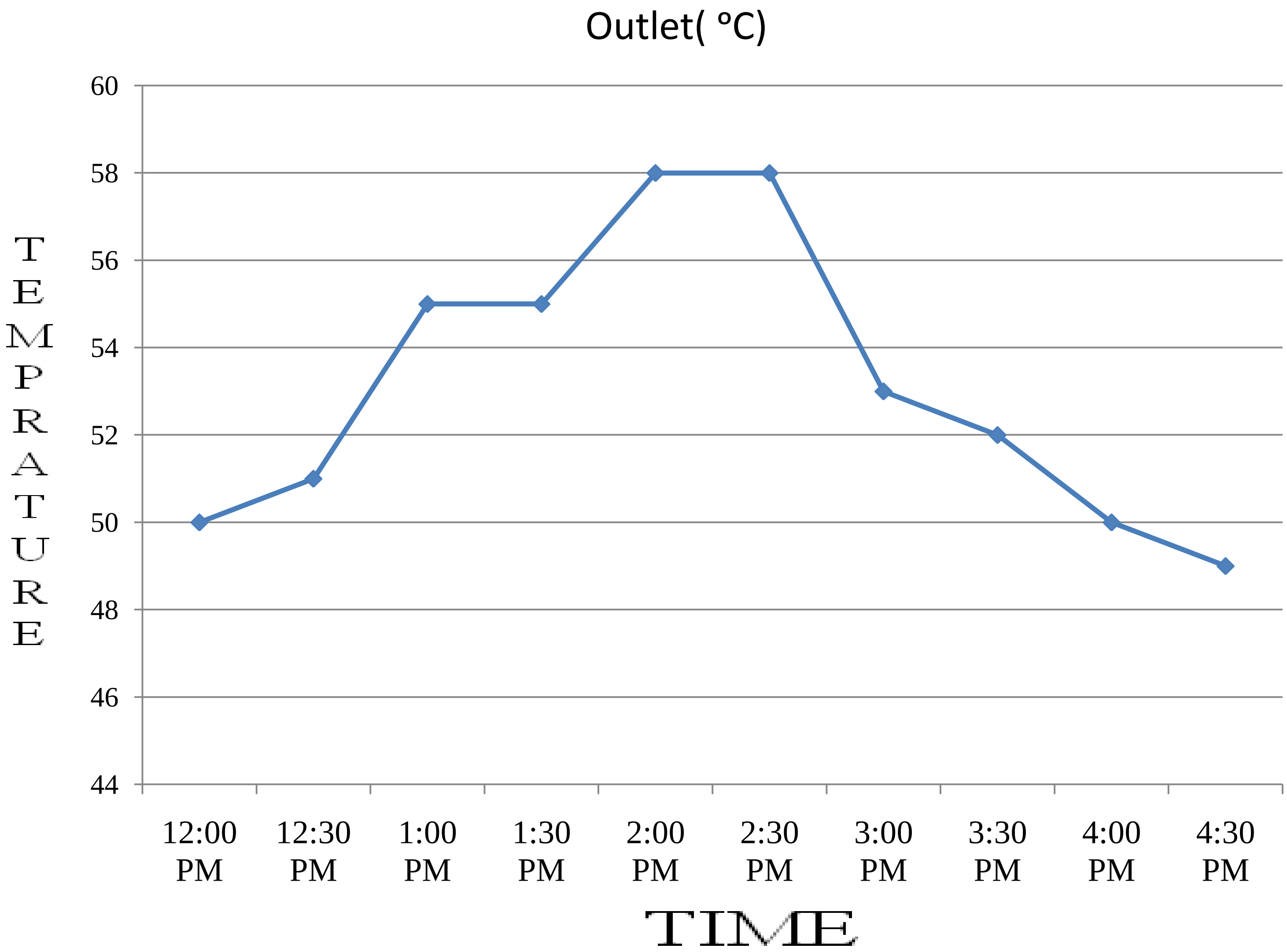
SINGLE AXIS OBSERVATION TABLE

NO	Time	(W/m2)	Water temperature of concentrating plate collector	
			Inlet(°C)	Outlet(°C)
1	12:00 PM	722	32	50
2	12:30 PM	740	33	51
3	1:00 PM	742	36	55
4	1:30 PM	743	35	55
5	2:00 PM	754	37	58
6	2:30 PM	776	35	58
7	3:00 PM	768	34	53
8	3:30 PM	752	36	52
9	4:00 PM	740	37	50
10	4:30 PM	718	35	49

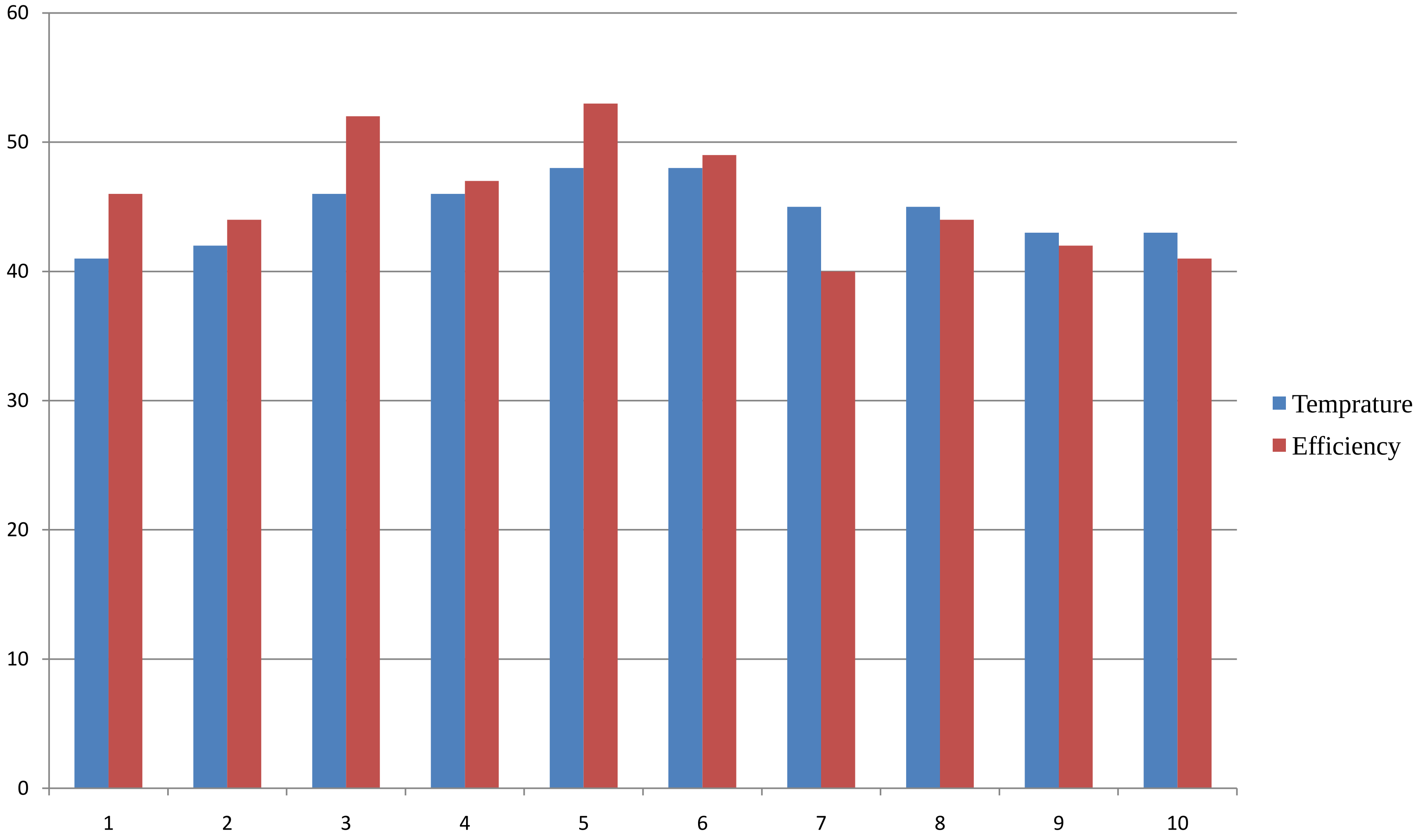
RESULT TABLE

N0	Output of the flat plate Collector(Q) (Joules)	Efficiency of concentrating plate collector (η)
1	188190	0.4605
2	188190	0.4493
3	219555	0.5228
4	198645	0.4724
5	230010	0.5389
6	219555	0.4998
7	177735	0.4088
8	188190	0.4421
9	177735	0.4244
10	167280	0.4116
	Avg. Q = 195508.5	Avg. η = 0.4630

Water outlet temperature Vs Time Graph



Temp. Vs Efficiency(%) Graph



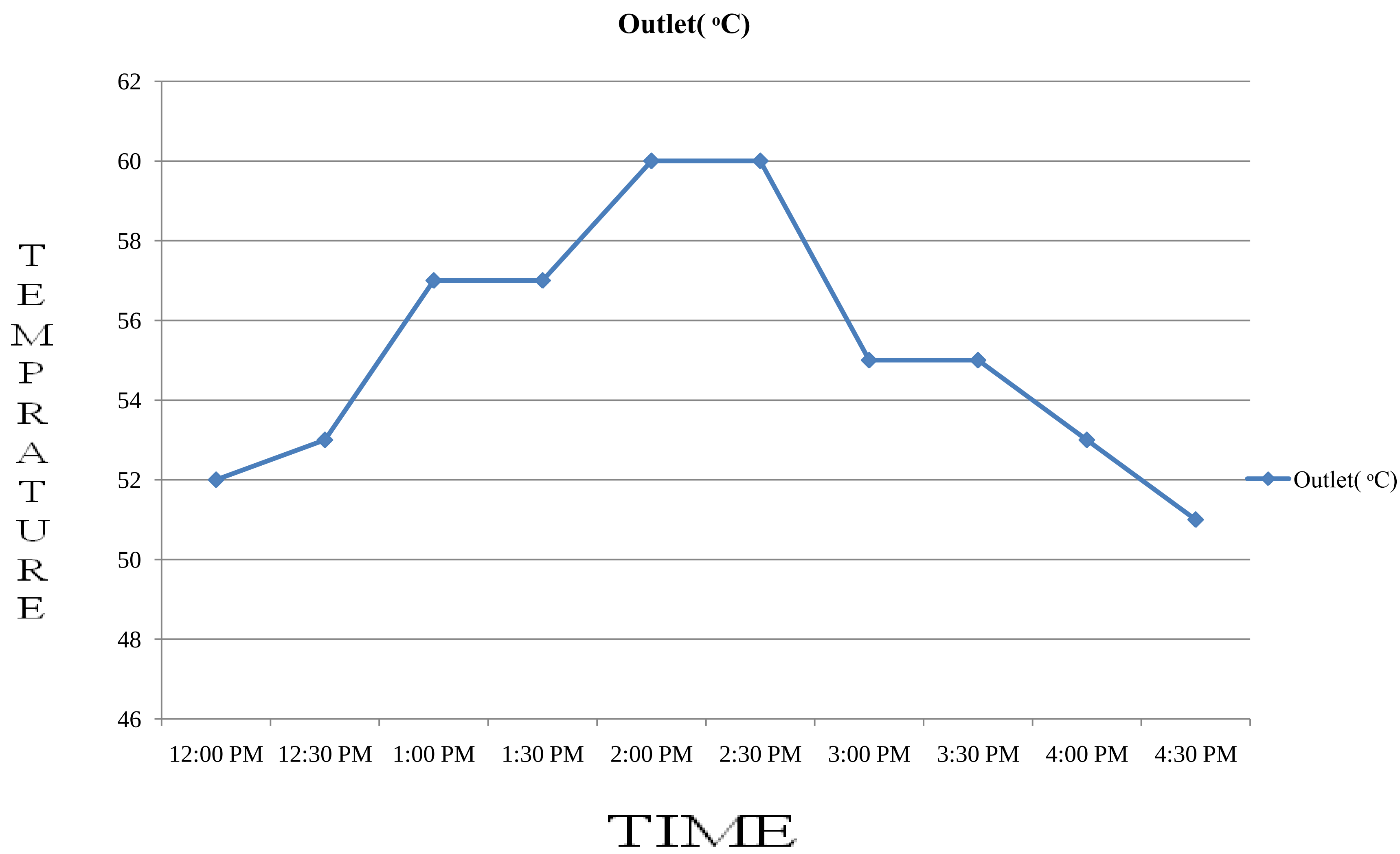
DUAL AXIS OBSERVATION TABLE

NO	Time	R (W/m2)	Water temperature of concentrating plate collector	
			Inlet(^oC)	Outlet(^oC)
1	12:00 PM	740	32	52
2	12:30 PM	752	33	53
3	01:00 PM	760	34	57
4	01:30 PM	763	36	57
5	02:00 PM	775	36	60
6	02:30 PM	820	37	60
7	03:00 PM	810	36	55
8	03:30 PM	758	34	55
9	04:00 PM	752	33	53
10	04:30 PM	736	33	51

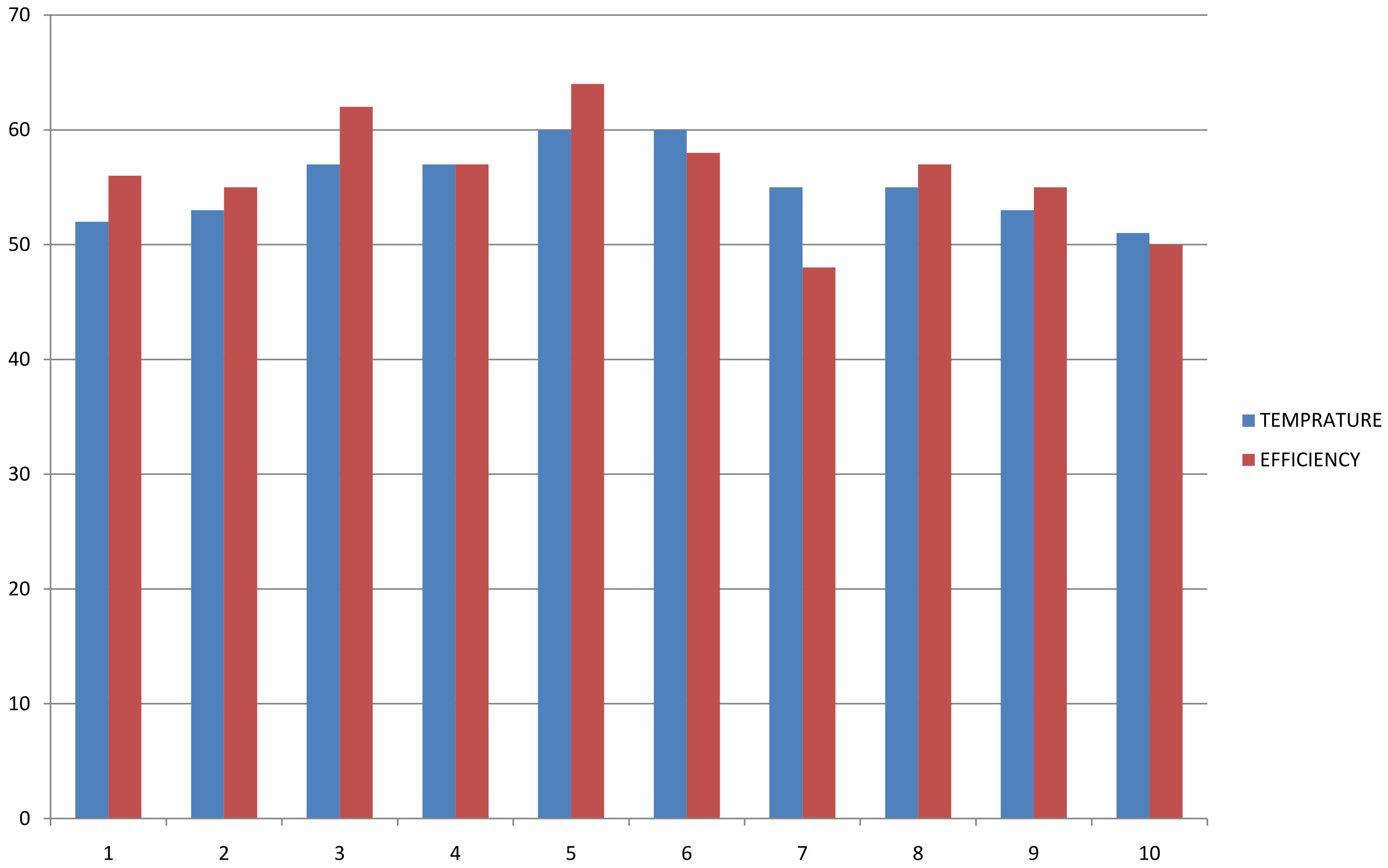
RESULT TABLE

N0	Output of the concentrating plate Collector(Q) (Joules)	Efficiency of concentrating plate collector (η)
1	209100	0.5606
2	209100	0.5517
3	240465	0.6278
4	219555	0.5709
5	250920	0.6424
6	240465	0.5818
7	198645	0.4866
8	219555	0.5747
9	209100	0.5517
10	188190	0.5073
	Avg. Q = 178780.5	Avg. η = 0.5655

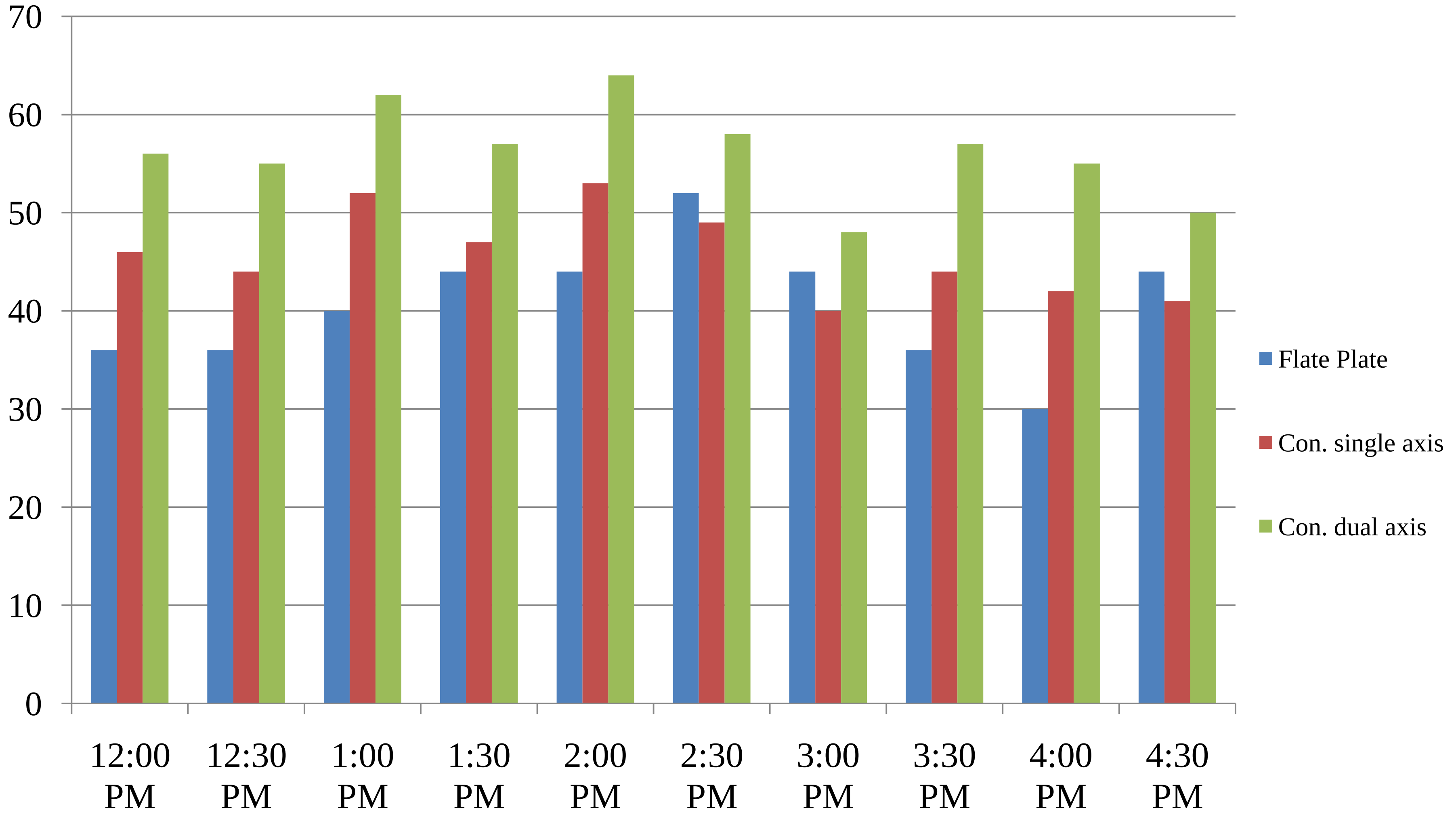
Water outlet temperature Vs Time Graph



Temp. Vs Efficiency(%) Graph



COMPARE BETWEEN FP&CSA&CDA



CONCLUSION:-

- We have studied research papers and analysis of flat plate collector. After finding the average efficiency of FPC. we got to know that the average efficiency of FPC is 0.40929 (40.9%) which is very less.There of after we have studied research paper of CPC ,if we use concentrating plate collector we have find the single axis CPC average efficiency is 0.4630(46.3%) and dual axis CPC average efficiency is 0.5655(56.5%),we can increase the average efficiency.

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THANK YOU…