PROJECT - II

Report on

THERMOELECTRIC CONCENTRATOR

Submitted in fulfillment of the requirements

of the degree of

Bachelor of Engineering
(Electronics and Telecommunication Engineering)

by

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Certificate of Approval

This is to certify that, the Project - II report entitled

"THERMOELECTRIC CONCENTRATOR "

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Declaration

We wish to state that work embodied in this dissertation entitled "**ThermoElectric Concentrator**"has been carried out under the guidance of "Mrs.Debajani Mahanta" at Department of Electronics and Telecommunication Engineering, Ramrao Adik Institute of Technology during 2019-2020.

We declare that the work being presented forms my own contribution and has not been submitted for any other Degree or Diploma of any University/Institute. Wherever references have been made to previous works of others, it has been clearly indicated. We understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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A renewable resource is a resource which can be replaced naturally and use repeatedly. Renewable energy never runs out, for example: solar energy provide heat from the sun and never runs out. Renewable resource harvesting and use typically don't produce pollution or benefaction to global warming. The use of renewable resources and energy sources is increasing worldwide, with certain nations, such as Bhutan, and US states, such as California, beginning to rely entirely on renewable energy. Solar energy is radiant light and heat from the Sun that is harnessed using a range of ever-evolving technologies such as solar heating, photovoltaic, solar thermal energy, molten salt power plants and artificial photosynthesis.

In the present rapidly developing world, generation and consumption of electrical energy playing an important role without affecting the nature of the environment. To achieve the environment-friendly electrical power generation a lot of research was done and succeeded with technologies such as photovoltaic, concentrated solar power, wind energy, tidal energy...etc. This work is aiming a new way to convert solar energy into electrical energy by using a ss of erieThermocouples and parabolic reflector. Series of Thermocouples contain a number of hot and cold Junctions. Thermocouple hot junctions were arranged at the focal point of parabolic reflector whereas cold junctions insulated with some thermal insulation to reduce heat transfer. Parabolic reflector concentrates solar radiation at Thermocouple hot junctions; this rises intensity of radiation due to this temperature of hot junction increases. Cold junctions are maintained at low temperature by using an external cooling medium. The temperature difference between hot and cold junction induces an e.m.f in series of Thermocouples. This induce e.m.f is store in the batteries. The heat which is produce also can be store.

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Chapter 1

INTRODUCTION

1.1 Solar Energy

A few researchers have brought up the concernment of interchange inexhaustible wellsprings of energy for the fight to come against 'Energy Crisis'. Among the inexhaustible wellsprings of energy, sun based energy offers a functional answer for the energy issue which is blurring the desire for humankind. Energy is consider as a way to improve the personal satisfaction and increment the efficiency and work, in this way ulter the territorial, national and global approaches and projects. The energy needs of our nation are increasing at a quick rate, and indigenous energy assets are restricted and may not be adequate over the long haul to help financial improvement. Improve the energy productivity and limiting the energy force of the economy ought to clearly comprise the premise of a convenient energy methodology. The energy inconvenience powers people, association and governments to all the more likely use new and inexhaustible wellsprings of energy, which alone can meet the energy issue. A few plans have been acknowledged to meet the circumstance, for example, energy protection, use and use of sustainable power source innovations.

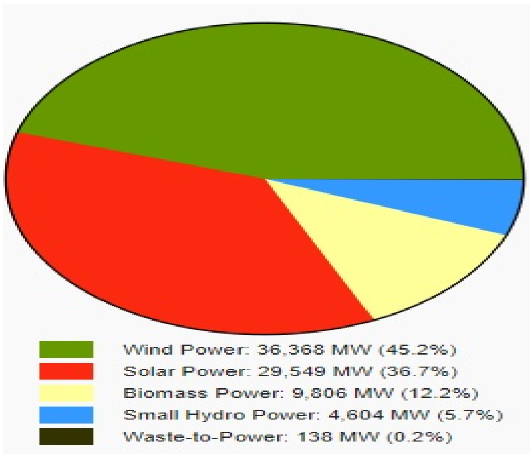


Figure 1.1: The Potential for Renewable Energy Sources

The important recommendation for the creating nations like India is to tackle non-traditional sustainable power sources on an astounding scale. Sustainable power sources are gaining significance against the regular energy sources in light of the fact that customary energy sources are embedded with a few imperatives like amount and nature of save, the board of transportation and ecological contamination. Among the sustainable power sources, for example, wind energy, sunlight based energy, biomass and tidal energy, sun powered energy acquires distinction in light of the fact that different sources include high innovative improvement. ”Sun based energy is the energy of things to come, not only an alternative”

The sun is the most enormous energy hotspot for the earth.Wind, petroleum derivative, hydro and biomass energy have their starting points in daylight. Sun oriented energy falls on the outside of the earth at a pace of 120petawatts, (1 petawatt = 1015 watt). This implies all the sun oriented energy got from the sun in every days can all around satisfied the entire world's interest for over 20 years. We can figure the potential for each sustainable power source dependent on the present innovation Future advances in innovation will lead the best approach to higher potential for every energy source. Notwithstanding, the overall interest for energy is anticipate continue ascending at 5 percent every year. Sun powered energy is the main decision that can fulfill such a gigantic and consistently rising interest.

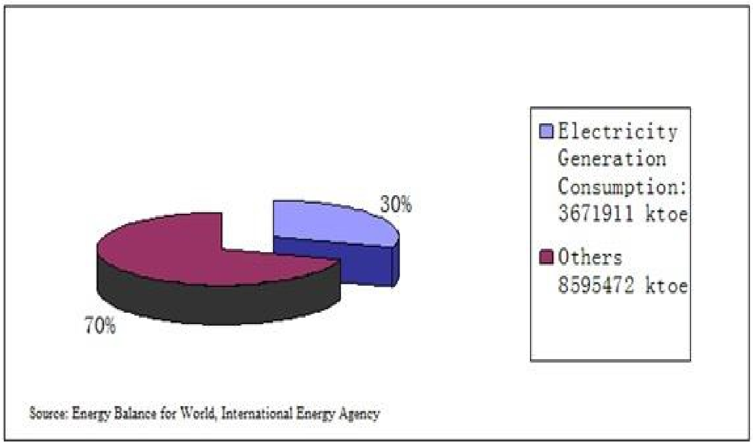


Figure 1.2: Electrical Energy Consumption Percentage of Total Energy

There are a few applications for sun based energy, for test: power age, photochemical, sun oriented impetus, sun based desalination, and room temperature control. The assortment of sun oriented energy and its exchange to power energy will have wide application and profound effect on our general public, so it has pulled in the consideration of the scientists.

1.1.1 Needs

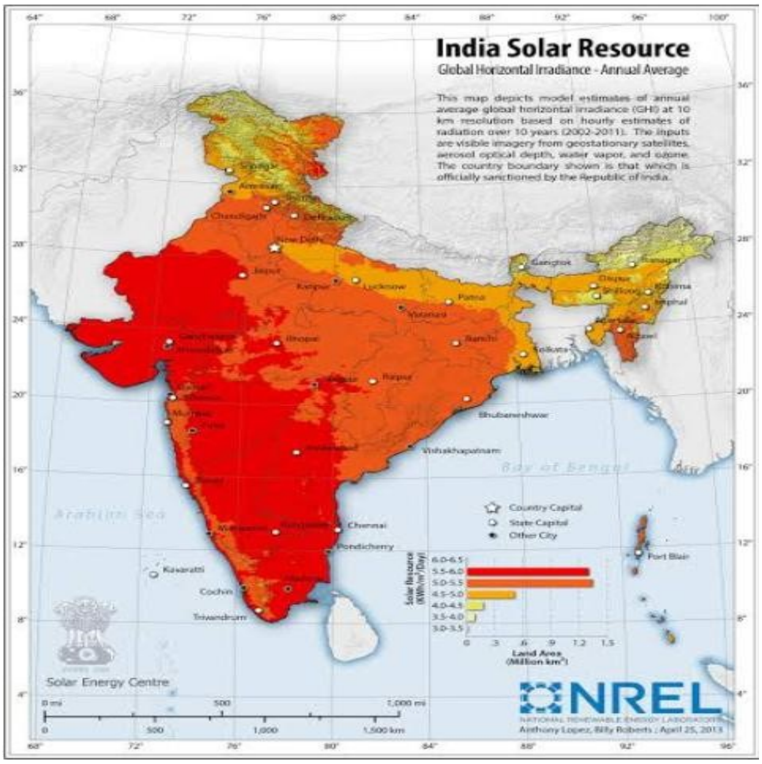


Figure 1.3: Indian Solar Resources

Energy has become the most elevated look at word with respect to government's perspective. As the number of inhabitants on the planet continuing rising, the non sustainable assets diminish step by step (e.g non-renewable energy sources). Researcher's gauge 50% ascent in overall energy utilization in 2030 and 70% to 100% in 2050. The bio and fossil can't beat this energy emergency in future. Every year, the sun sends over a billion terawatt long periods of energy to the Earth, which is equivalent to multiple times the world's power needs along these lines, the world is moving towards the sun based energy. Sustainable power source assets are getting numerous significant due to constantly diminish in customary energy source. Sun energy which is ordinarily called as sun oriented energy is the biggest assets of sustainable power source. Everywhere throughout the world, particularly in our nation more often than not in a year sun gives a decent introduction. The utilization of sun for lighting during day time and warming in winter season is definitely not another idea. This was accomplished for quite a long time. Be that as it may, because of rising energy issues world is moving toward using sustainable power source assets.

1.2 The Laws of Thermodynamics

The laws of thermodynamics define basic physical quantities (temperature, energy, and entropy) that characterize thermodynamic systems

1.2.1 The First Law of Thermodynamics

The first law of thermodynamics, also known as Law of Conservation of Energy, states that energy can neither be created nor destroyed; energy can only be transferred or changed from one form to another. For example, turning on a light would appear to produce energy; however, it is electrical energy that is converted.

A way of convey the first law of thermodynamics is that any change in the internal energy (E) of a system is given by the sum of the heat (q) that flows across its boundaries and the work (w) done on the system by the surroundings:

E = q+w

This law says that there are two kinds of processes, heat and work, that can lead to a change in the internal energy of a system. Since both heat and work can be measured and specified, this is the same as saying that any change in the energy of a system must result in a corresponding change in the energy of the surroundings outside the system. In other words, energy cannot be created or destroyed. If heat flows into a system or the surroundings do work on it, the internal energy rises and the sign of q and w are positive. Conversely, heat flow out of the system or work done by the system (on the surroundings) will be at the expense of the internal energy, and q and w will therefore be negative.

1.2.2 The Second Law of Thermodynamics

The second law of thermodynamics says that the entropy of any isolated system always increases. Isolated systems spontaneously evolve towards thermal equilibrium—the state of maximum entropy of the system. More simply put: the entropy of the universe (the ultimate isolated system) only increases and never decreases.
A simple way to think of the second law of thermodynamics is that a room, if not cleaned and tidied, will invariably become more messy and disorderly with time – regardless of how careful one is to keep it clean. When the room is cleaned, its entropy decreases, but the effort to clean it has resulted in an increase in entropy outside the room that exceeds the entropy lost.

1.2.3 The Third Law of Thermodynamics

The third law of thermodynamics states that the entropy of a system approaches a constant value as the temperature approaches absolute zero. The entropy of a system at absolute zero is typically zero, and in all cases is determined only by the number of different ground states it has. Specifically, the entropy of a pure crystalline substance (perfect order) at absolute zero temperature is zero. This statement holds true if the perfect crystal has only one state with minimum energy.

1.3 History

A legend has it that Archimedes utilized a ”consuming glass” to focus daylight on the attacking Roman fleet and repulse them from Syracuse. In 1973 a Greek researcher, Dr.

Ioannis Sakkas, inquisitive about whether Archimedes could truly have obliterated the Roman fleet in 212 BC, arranged almost 60 Greek mariners, each holding an elongated mirror tipped to get the sun's beams and direct them at a tar-shrouded pressed wood outline 49 m (160 ft) away. The boat burst into flames following a couple of moments; be that as it may, history specialists keep on questioning the Archimedes story.

In 1866, Auguste Mouchout utilized an allegorical trough to produc steam for the principal sun based steam motor. The principal patent for a sun oriented gatherer was gotten by the Italian Alessandro Battaglia in Genoa, Italy, in 1886. Over the next years, invntors, for example, John Ericsson and Frank Shuman created focusing sunlight based controlled dvices for water system, refrigration, and locomtion. In 1913 Shuman completed a 55 HP illustrative sun based warm vitality station in Maadi, Egypt for water system. The primary sun based force framework utilizing a mirror dish was worked by Dr. R.H. Goddard, who was at that point notable for his examination on fluid energized rockets and composed an article in 1929 in which he affirmed that all the past impediments had been addressed.

Educator Giovanni Francia (1911–1980) structured and fabricated the primary concentrated-sun powered plant, which went into activity in Sant'Ilario, close to Genoa, Italy in 1968. This plant had the engineering of the present force tower plants with a sun oriented beneficiary in the focal point of a field of sunlight based gatherers. The plant had the option to deliver 1 MW with superheated steam at 100 bar and 500 C. The 10 MW Solar One force tower was created in Southern California in 1981. Sun based One was changed over into Solar Two of every 1995, executing another plan with a liquid salt blend (60% sodium nitrate, 40% potassium nitrate) as the collector working liquid and as a capacity medium. The liquid salt methodology demonstrated compelling, and Solar Two worked effectively until it was decommissioned in 1999. The illustrative trough innovation of the close by Solar Energy Generating Systems (SEGS), started in 1984, was progressively useful. The 354 MW SEGS was the biggest sun oriented force plant on the planet, until 2014.

No business concentrated sun oriented was developed from 1990 when SEGS was finished until 2006 when the Compact straight Fresnel reflector framework at Liddell Power Station in Australia was fabricated. Not many different plants were worked with this structure in spite of the fact that the 5 MW Kimberlina Solar Thermal Energy Plant opened in 2009.

In 2007, 75 MW Nevada Solar One was assembled, a trough structure and the primary enormous plant since SEGS. Somewhere in the range of 2009 and 2013, Spain worked more than 40 illustrative trough frameworks, institutionalized in 50 MW blocks.

Because of the achievement of Solar Two, a business power plant, called Solar Tres Power Tower, was worked in Spain in 2011, later renamed Gemasolar Thermosolar Plant. Gemasolar's outcomes made ready for additional plants of its sort. Ivanpah Solar Power Facility was developed simultaneously yet without warm capacity, utilizing petroleum gas to preheat water each morning.

Most thought sunlight based force plants utilize the explanatory trough structure, rather than the force tower or Fresnel frameworks. There have likewise been varieties of explanatory trough frameworks like the coordinated sunlight based joined cycle (ISCC) which consolidates troughs and ordinary non-renewable energy source heat systems.

CSP was initially treated as a contender to photovoltaics, and Ivanpah was worked without vitality stockpiling, albeit Solar Two had incorporated a few hours of warm stockpiling. By 2015, costs for photovoltaic plants had fallen and PV business power was selling for 13 of late CSP contracts. In any case, progressively, CSP was being offered with 3 to 12 hours of warm vitality stockpiling, making CSP a dispatchable type of sun powered vitality. All things considered, it is progressively observed as rivaling flammable gas and PV with batteries for adaptable, dispatchable power.

Chapter 2

LITERATURE SURVEY

A brief review of use of Renewable Sources towards energy generation.

A. Borah, S.M. Khayer and L.N. Sethi., for efficient drying of product through indirect drying method, a compound parabolic concentrator (CPC) were installed. Six numbers of semi-cylindrical parabolic concentrators were interpolated on a receiver plate for direct conversion of solar energy to thermal energy by trapping the maximum incident rays into metallic tubes which were placed on focus lines of the parabolas. Experiments were carried to study the comparative performance of a solar flat plate collector and compound parabolic concentrator of same size. Average temperature rise of 9.50 C was observed during the period. A manual solar tracking was facilitated along the two axes up to 4.68o vertical and 11.54o horizontal. Average temperature increase of 11.2o C could be achieved over the ambient. Solar radiation trapping time at a constant temperature level was increased by 1.5 hours in comparison to fixed CPC.

Charles Kutscher, Frank Burkholder, Kathleen Stynes., have prescribed about the overall efficiency of a parabolic trough collector is a function of both the fraction of direct normal radiation absorbed by the receiver (the optical efficiency) and the heat lost to the environment when the receiver is at operating temperature. The overall efficiency can be determined by testing the collector under actual operating conditions or by separately measuring these two components. It describes how outdoor measurement of the optical efficiency is combined with laboratory measurements of receiver heat loss to obtain an overall efficiency curve. Further, it presents a new way to plot efficiency that is more robust over a range of receiver operating temperatures.

R. Forristall., proposed there report which describes the development, validation, and use of a heat transfer model implemented in Engineering Equation Solver (EES). The model determines the performance of a parabolic trough solar collector's linear receiver, also called a heat collector element (HCE). All heat transfer and thermodynamic equations, optical properties, and parameters used in the model are discussed. The modeling assumptions and limitations are also discussed, along with recommendations for model improvement. The model was implemented in EES in four different versions. Two versions were developed for conducting HCE design and parameter studies, and two versions were developed for verifying the model and evaluating field test data. One- and two-dimensional energy balances were used in the codes, where appropriate. Each version of the codes is discussed briefly, which includes discussing the relevant EES diagram windows, parameter tables, and lookup tables. Detailed EES software instructions are not included; however, references are provided. Model verification and a design and parameter study to demonstrate the model versatility are also presented. The model was verified by comparing the field test versions of the EES codes with HCE experimental results. The design and parameter study includes numerous charts showing HCE performance trends based on different design and parameter inputs. Based on the design and parameter study, suggestions for HCE and trough improvements and further studies are given. The HCE performance software model compared well with experimental results and provided numerous HCE design insights from the design and parameter study.

Hank Price et al., have proposed about parabolic trough solar technology is the most proven and lowest cost large-scale solar power technology available today, primarily because of the nine large commercial-scale solar power plants that are operating in the California Mojave Desert. These plants developed by Luz International Limited and referred to as Solar Electric Generating Systems (SEGS), range in size from 14–80 MW and represent 354 MW of installed electric generating capacity. More than 2,000,000 m2 of parabolic trough collector technology has been operating daily for up to 18 years, and as the year 2001 ended, these plants had accumulated 127 years of operational experience. The Luz collector technology has demonstrated its ability to operate in a commercial power plant environment like no other solar technology in the world. Although no new plants have been built since 1990, significant advancements in collector and plant design have been made possible by the efforts of the SEGS plants operators, the parabolic trough industry, and solar research laboratories around the world. This paper reviews the current state of the art of parabolic trough solar power technology and describes the RD efforts that are in progress to enhance this technology. The paper also shows how the economics of future parabolic trough solar power plants are expected to improve.

R. McConnell, M. Symko-Davies, and H. Hayden., proposed their views of about solar energy and its characteristics. Solar energy is more plentiful, more predictable and is less site specific than wind. Despite solar energy advantages and our best intentions, wind farms are common place while "sun farms" are still a rarity. It seems inevitable that the scales will tip but the natural time scales are too long (for the author at least). How do we pick up the pace. This above contents represents the author's view of the solution, which includes a mixture of technology, commercial management, capital, collaboration and influence. Dave Holland is the Managing Director of Solar Systems and a Director of Renewable Energy Generators Australia – an industry group that represents more than 90% of Australia's renewable energy based generation assets.

Soteris A. Kalogirou. In this paper a survey of the various types of solar thermal collectors and applications is presented. Initially, an analysis of environmental problems related to the use of conventional sources of energy is presented and the benefits offered by renewable energy systems are outlined. A historical introduction into the uses of solar energy is attempted followed by a description of the various types of collectors including flat-plate, compound parabolic, evacuated tube, parabolic trough, Fresnel lens, parabolic dish and heliostat field collectors. This is followed by an optical, thermal and thermodynamic analysis of the collectors and a description of the methods used to evaluate their performance. Typical applications of the various types of collectors are presented in order to show to the reader the extent of their applicability. These include solar water heating, which comprise thermo syphon, integrated collector storage, direct and indirect systems and air systems, space heating and cooling, which comprise, space heating and service hot water, air and water systems and heat pumps, refrigeration, industrial process heat, which comprise air and water systems and steam generation systems, desalination, thermal power systems, which comprise the parabolic trough, power tower and dish systems, solar furnaces, and chemistry applications. As can be seen solar energy systems can be used for a wide range of applications and provide significant benefits, therefore, they should be used whenever possible.

Ted Collins all., Parabolic-trough solar water heating is a well-proven renewable energy technology with considerable potential for application at Federal facilities. For the United States, parabolic-trough water-heating systems are most cost effective in the Southwest where direct solar radiation is high. Jails, hospitals, barracks, and other facilities that consistently use large volumes of hot water are particularly good candidates, as are facilities with central plants for district heating. As with any renewable energy or energy efficiency technology requiring significant initial capital investment, the primary condition that will make a parabolic-trough system economically viable is if it is replacing expensive conventional water heating. In combination with absorption cooling systems, parabolic-trough collectors can also be used for air-conditioning. Industrial Solar Technology (IST) of Golden, Colorado, is the sole current manufacturer of parabolic-trough solar water heating systems. IST has an Indefinite Delivery/Indefinite Quantity (IDIQ) contract with the Federal Energy Management Program (FEMP) of the U.S. Department of Energy (DOE) to finance and install parabolic-trough solar water heating on an Energy Savings Performance Contract (ESPC) basis for any Federal facility that requests it and for which it proves viable. For an ESPC project, the facility does not pay for design, capital equipment, or installation. Instead, it pays only for guaranteed energy savings. Preparing and implementing delivery or task orders against the IDIQ is much simpler than the standard procurement process. This Federal Technology Alert (FTA) of the New Technology Demonstration Program is one of a series of guides to renewable energy and new energy-efficient technologies. It is designed to give Federal facility managers the information they need to decide whether they should pursue parabolic-trough solar water heating or air conditioning for their facility and to know how to go about doing so. Software available from FEMP's Federal Renewables Program at the National Renewable Energy Laboratory (NREL) enables preliminary analysis of whether parabolic-trough collectors would be cost effective for any situation based on minimum data. This FTA describes the technology of parabolic-trough collectors, solar water heating systems, and absorption cooling. It points out the types of situations where parabolic-trough solar water heating is most likely to be cost effective and describes the ESPC process available to Federal facilities for parabolic-trough projects. In addition, sidebars provide indicators that a system will be effective, tips for ensuring successful operation, and sources for determining system data. Case studies for a 10-year-old system at a county jail and for one just starting construction at a Federal prison include economic evaluation data.

2.1 Background Research

Concentrating Solar Power technology is introduced during 18's. Mr. Auguste Mouchout is the first person that use the parabolic trough technique to produce steam for steam engine in 1866. The first patent for solar collector is invented by Mr. Battaglia in Genoa, Italy in 1866. Later on, John Ericson development many CSP units for the irrigation, refrigeration and locomotion.

2.2 Early Commercial Adaption

Solar Energy utilization techniques are not present research but scientist's are working from many years to utilize solar energy.

1897:

"Frank Shunam",a US Engineer and pioneer of solar energy develop a small solar engine which worked by reflecting solar energy on the boxes which are filled with fluid which has boiling point less than water.

1912-1913:

Shuman build a first world largest Solar Thermal Power Station in Madi Egypt.He use parabolic troughs to power a 45-52 energy that pumped more than 22,000 litres of water per minute from the Nile River to adjacent cotton fields.

2.3 CSP With Thermal Energy Storage

In a CSP plant that incorporates storage, the sunlight based energy is first used to warm the liquid salt or engineered oil which is put away giving thermal/heat energy at high temperature in protected tanks. Later the hot liquid salt (or oil) is utilized in a steam generator to create steam to produce power by steam turbo generator according to necessity. CSP with thermal storage frameworks are likewise accessible utilizing Brayton cycle with air rather than steam for creating power and additionally steam nonstop. In this way sun oriented energy which is accessible in sunlight just is utilized to produce power nonstop on request as a heap following force plant or sun based peaker plant. The thermal storage limit is demonstrated in long periods of intensity age at nameplate limit. Not at all like sun oriented PV or CSP without storage, the force age from sun powered thermal storage plants is dispatchable and self-supportable like coal/gas-terminated force plants, yet without the contamination. CSP with thermal energy storage plants can likewise be utilized as cogeneration plants to supply both power and procedure steam nonstop. As of December 2018, CSP with thermal energy storage plants age cost have gone between 5c/kWh and 7c/kWh relying upon great to medium sun oriented radiation got at an area. Dissimilar to sunlight based PV plants, CSP with thermal energy storage plants can likewise be utilized monetarily nonstop to create just procedure steam supplanting contamination discharging petroleum products. CSP plant can likewise be coordinated with sun based PV for better synergy

2.4 Deployment Around The World

The commercial deployment of CSP plants started by 1984 in the US with the SEGS plants. The last SEGS plant was completed in 1990. From 1991 to 2005, no CSP plants were built anywhere in the world. Global installed CSP-capacity increased nearly tenfold between 2004 and 2013 and grew at an average of 50 percent per year during the last five of those years. 51 In 2013, worldwide installed capacity increased by 36% or nearly 0.9 gigawatt (GW) to more than 3.4 GW. Spain and the United States remained the

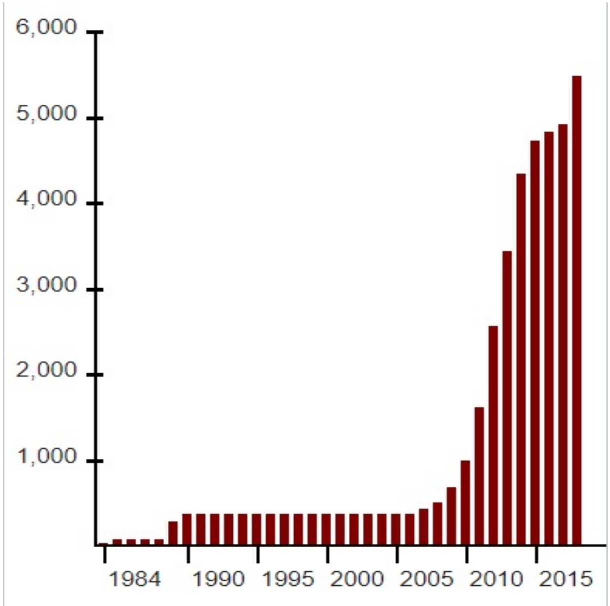


Figure 2.1: Worldwide CSP Capacity Since 1984 in MWp

global leaders, while the number of countries with installed CSP were growing but the rapid decrease in price of PV solar, policy changes and the global financial crisis stopped most development in these countries. 2014 was the best year for CSP but was followed by a rapid decline with only one major plant completed in the world in 2016. There is a notable trend towards developing countries and regions with high solar radiation with several large plants under construction in 2017.

country	Total	added
Spain	2,300	0
United states	1,738	0
South Africa	400	100
Morroco	380	200
India	225	0
China	210	200
United Arab Emirates	100	0
Saudi Arabia	50	50
Algeria	25	0
Egypt	20	0
Australia	12	0
Thailand	5	0

Table 2.1: National CSP Capacities in 2018 (MWp)

CSP is also increasingly competing with the cheaper photovoltaic solar power and with concentrator photovoltaics (CPV), a fast-growing technology that just like CSP is suited best for regions of high solar insolation. In addition, a novel solar CPV/CSP hybrid system has been proposed recently.

Chapter 3

PROPOSED METHOD

In this project we are construct a solar concentrator which serves as an energy utilizer for various applications. To design a parabolic trough to produce heat energy by capturing naturally available sunlight. The process output is depending upon light energy from the sun. The solar energy is get collected in the form of heat energy reflector. After this heat energy is get converted in the form of electric energy using thermocouple.

First we are constructing a Solar concentrator. There is various type of solar concentrator which we are going to see in upcoming chapters. We are construct Parabolic Concentrator to collect the radiation of solar. The parabolic concentrator concentrate the solar energy to it's focal length. The reflected energy is in the form of heat, this heat energy is fall on the absorber. The absorber get converted Heat energy into electric form using thermocouple. Concentrator is a mechanical device which concentrate the solar radiation on its focal point. The solar radiation reflected from the concentrator surface and fall on the absorber. So for this the surface of the reflector must be shiny or its have the property of reflection. To make the reflector more efficient we are use the Fresnel glass which reflect the solar radiation. Use of Fresnel glass improve the efficiency of the concentrator. Fresnel glass helps to collect more heat energy from sun. A Thermocouple is a device used to convert heat into electrical power. It measures the temperature difference between two points. Thermocouples is a sensor used to measure temperature. It consist of two wire legs made from different metals. The wires legs are welded together at one end, creating a junction. This junction is where the temperature is measured. Thermocouples are among the most widely used temperature sensors due to their wide availability and low cost.

In this project we are using sun tracking system for concentrator. The concentrator continuously track the sun using tracking system. Tracking system consist of motor and sensor. Sensor sense the intensity of sun and give instruction to motor to move the solar concentrator in suns direction. Tracking system is useful to increase the efficiency of the solar concentrator. It tracks the sun continuously by using light sensors. Two sensors are there to sense the intensity of light.

Chapter 4

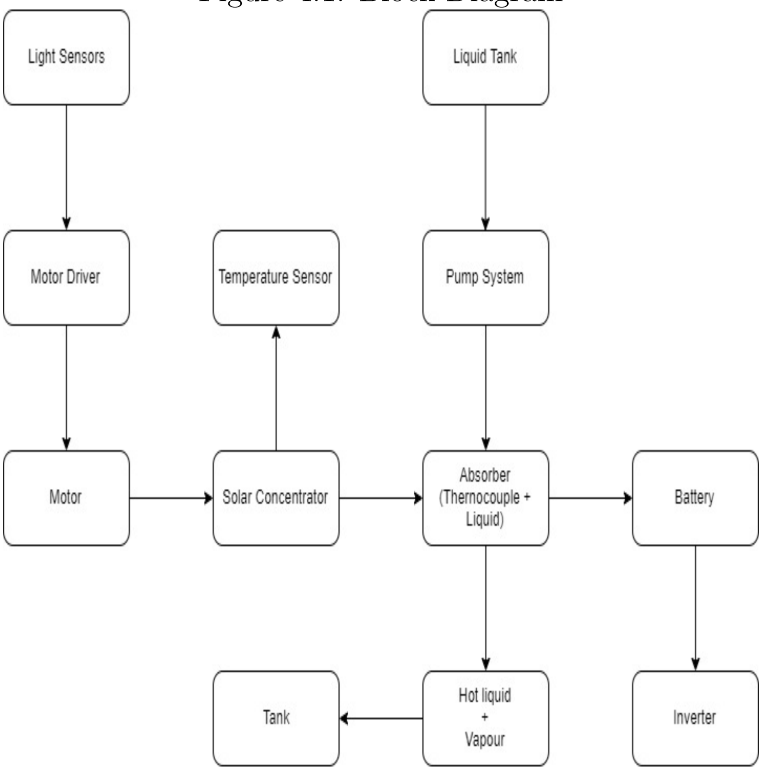
SYSTEM ARCHITECTURE

The System Architecture consists of the block diagram, various components used and the software used for programming the micro controller. This chapter will walk you through the entire project and explain the bits and pieces and have they are merged together to get the desired objective satisfied.

4.1 Block Diagram

The figure 4.1 gives an overview of the project along with its major components. The main block include the Solar Concentrator which concentrate sun radiation toward absorber. Absorber Absorb the heat energy and convert it into electric form using thermocouple. The energy generated by thermocouple is stored in the batteries. Sensors, Motor driver, Motor is part of Sun tracking system.

Figure 4.1: Block Diagram



4.2 Sun Tracking System

In this topic we are going to discuss about Tracking system. Tracking System consist of Light Sensor, Motor Driver, Motor, Manual Handle. Here in this section we discuss each component.

4.2.1 Light Sensor

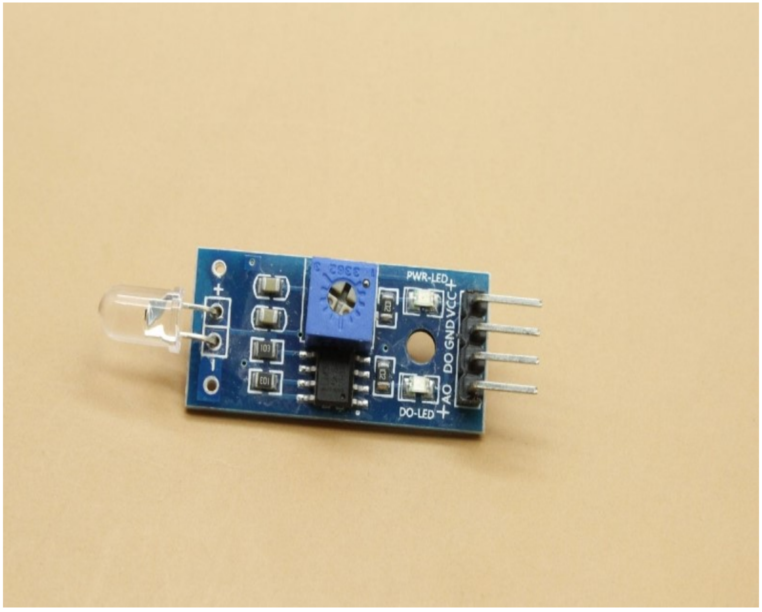


Figure 4.2: Light Sensor

Light sensor is the device which sense the intensity of the light. Here we use IR Light Sensor Model to sense the light intensity of sun. This intensity is given to the motor driver. The light sensor sense the light and gives output in the form of voltage. Its act as a register when there is no light. Here for solar tracking system we uses two or more IR sensor. Its detects the intensity of light.

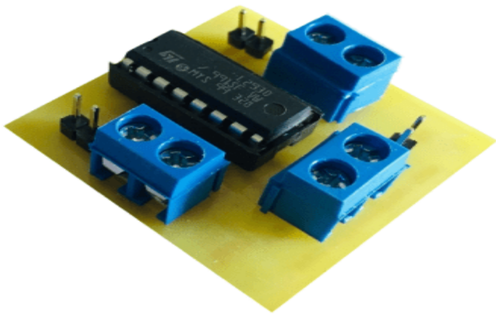
Specifications

Operating Voltage: 3.3V to 5V DC
Operating Current: 15ma
Output Digital - 0V or 5V, Adjustable trigger level from preset
Output Analog - 0V to 5V based on light on sensor
LEDs indicating output and power
PCB Size: 3.2cm x 1.4cm
LM393 based design

4.2.2 Motor Driver

Motor Driver is a device which drives the motor in clockwise or anti-clockwise direction. It takes input from the Light sensor module. The light sensor module provide he input, there is two light sensor is used. Light sensor detects the intensity of the sun, the intensity is converted in the form of voltage. The motor driver get two inputs from two light sensors. The motor sensor detects the difference between them and decide that whether motor move in clockwise direction or in anticlockwise direcction.

Figure 4.3: Motor Driver



Working Mechanism

Input1	Input2	Result
0	0	Stop
0	1	Anti-Clockwise
1	0	Clockwise
1	1	Stop

Table 4.1: Working Mechanism

4.2.3 Motor

In Motor section we are discuss about motors. We are using Servo motor to rotate the concentrator. A servomotor is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration. It consists of a suitable motor coupled to a sensor for position feedback. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use with servomotors.

Servo motor works on PWM (Pulse width modulation) principle, means its angle of rotation is controlled by the duration of applied pulse to its Control PIN. Basically servo

Figure 4.4: Servo Motor

motor is made up of DC motor which is controlled by a variable resistor (potentiometer) and some gears. High speed force of DC motor is converted into torque by Gears. We know that WORK= FORCE X DISTANCE, in DC motor Force is less and distance (speed) is high and in Servo, force is High and distance is less. Potentiometer is connected to the output shaft of the Servo, to calculate the angle and stop the DC motor on required angle.

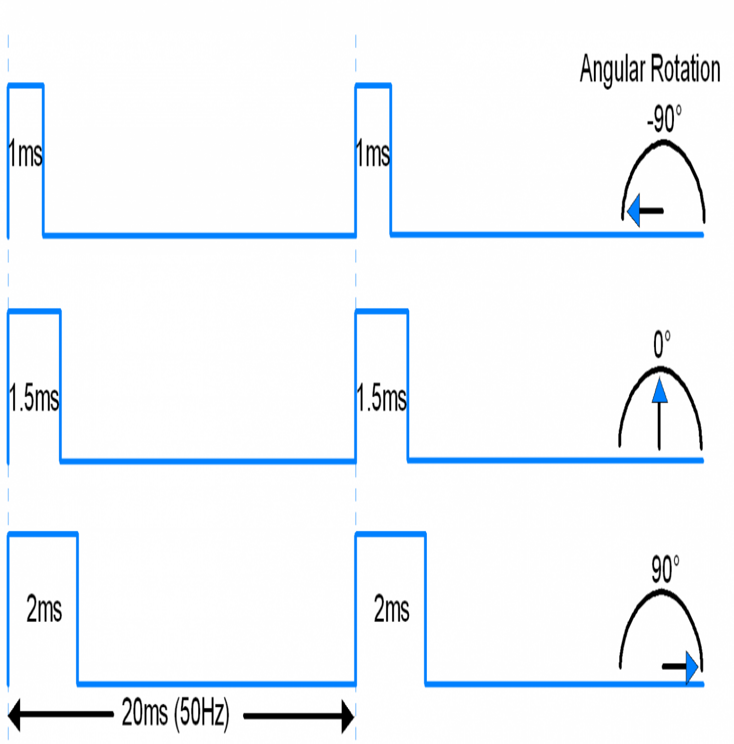


Figure 4.5: Servo Motor Angular Rotation

4.3 Concentrator

Concentrator:

Concentrator are oriented to track the sun so that the beam radiation will be directed on to the absorbing surface. Collector that directs radiation on to the receiver.

Collector:

The aperture of the concentrator is the opening through which the solar radiation enters the concentrator.

Current Concentrator Technology

Concentrated Solar Power is used to produce electricity (sometimes called solar thermoelectricity, usually generated through steam). Concentrated-solar technology systems use mirrors or lenses with tracking systems to focus a large area of sunlight onto a small area. The concentrated light is then used as heat or as a heat source for a conventional power plant (solar thermoelectricity). The solar concentrators used in Concentrated Solar Power systems can often also be used to provide industrial process heating or cooling, such as in solar air conditioning.

Concentrating technologies exist in four optical types, namely parabolic trough, dish, concentrating linear Fresnel reflector, and solar power tower. Parabolic trough and concentrating linear Fresnel reflectors are classified as linear focus collector types. Dish and solar tower as of the point focus type. Linear focus collectors achieve medium concentration (50 suns and over), and point focus collectors achieve high concentration (over 500 suns) factors. Although simple, these solar concentrators are quite far from the theoretical maximum concentration. For example, the parabolic-trough concentration gives about 13 of the theoretical maximum for the design acceptance angle, that is, for the same overall tolerances for the system. Approaching the theoretical maximum may be achieved by using more elaborate concentrators based on non imaging optics.

Different types of concentrators produce different peak temperatures and correspondingly varying thermodynamic efficiencies, due to differences in the way that they track the sun and focus light. New innovations in Concentrated Solar Power technology are leading systems to become more and more cost-effective.

4.4 Types of Concentrator

4.4.1 Parabolic Trough

A parabolic trough is a type of solar thermal collector that is straight in one dimension and curved as a parabola in the other two, lined with a polished metal mirror. The sunlight which enters the mirror parallel to its plane of symmetry is focused along the focal line, where objects are positioned that are intended to be heated. In a solar cooker, for example, food is placed at the focal line of a trough, which is cooked when the trough is aimed so the Sun is in its plane of symmetry.

For other purposes, a tube containing a fluid runs the length of the trough at its focal line. The sunlight is concentrated on the tube and the fluid heated to a high temperature by the energy of the sunlight. The hot fluid can be piped to a heat engine, which uses

Figure 4.6: Parabolic Reflector

the heat energy to drive machinery, or to generate electricity. This solar energy collector is the most common and best known type of parabolic trough.

When heat transfer fluid is used to heat steam to drive a standard turbine generator, thermal efficiency ranges from 60-80%. The overall efficiency from collector to grid, i.e. (Electrical Output Power)/(Total Impinging Solar Power) is about 15%, similar to PV (Photovoltaic Cells) but less than Stirling dish concentrators. Large-scale solar thermal power plants need a method for storing the energy, such as a thermocline tank, which uses a mixture of silica sand and quartzite rock to displace a significant portion of the volume in the tank. It is then filled with the heat transfer fluid, typically a molten nitrate salt.

Efficiency

The trough is usually aligned on a north-south axis, and rotated to track the sun as it moves across the sky each day. Alternatively, the trough can be aligned on an east-west axis; this reduces the overall efficiency of the collector due to the sunlight striking the collectors at an angle but only requires the trough to be aligned with the change in seasons, avoiding the need for tracking motors. This tracking method approaches theoretical efficiencies at the spring and fall equinoxes with less accurate focusing of the light at other times during the year. The daily motion of the sun across the sky also introduces errors, greatest at the sunrise and sunset and smallest at noon. Due to these sources of error, seasonally adjusted parabolic troughs are generally designed with a lower concentration acceptance product.

Parabolic trough concentrators have a simple geometry, but their concentration is about 1/3 of the theoretical maximum for the same acceptance angle, that is, for the same overall tolerances of the system to all kinds of errors, including those referenced above. The theoretical maximum is better achieved with more elaborate concentrators based on primary-secondary designs using nonimaging optics which may nearly double the concentration of conventional parabolic troughs and are used to improve practical designs such as those with fixed receivers.

Heat transfer fluid (usually thermal oil) runs through the tube to absorb the concentrated sunlight. This increases the temperature of the fluid to some 400 C. The heat transfer fluid is then used to heat steam in a standard turbine generator. The process is economical and, for heating the pipe, thermal efficiency ranges from 60-80%. The overall efficiency from collector to grid, i.e. (Electrical Output Power)/(Total Impinging Solar Power) is about 15%, similar to PV (Photovoltaic Cells) but less than Stirling dish concentrators.

4.4.2 Solar Power Tower

The solar power tower, also known as 'central tower' power plants or 'heliostat' power plants or power towers, is a type of solar furnace using a tower to receive the focused sunlight. It uses an array of flat, movable mirrors (called heliostats) to focus the sun's rays upon a collector tower (the target). Concentrated solar thermal is seen as one viable solution for renewable, pollution-free energy.

Figure 4.7: Solar Power Tower

Early designs used these focused rays to heat water, and used the resulting steam to power a turbine. Newer designs using liquid sodium have been demonstrated, and systems using molten salts (40% potassium nitrate, 60% sodium nitrate) as the working fluids are now in operation. These working fluids have high heat capacity, which can be used to store the energy before using it to boil water to drive turbines. These designs also allow power to be generated when the sun is not shining.

Power towers (also known as 'central tower' power plants or 'heliostat' power plants) capture and focus the sun's thermal energy with thousands of tracking mirrors (called heliostats) in roughly a two square mile field. A tower resides in the center of the heliostat field. The heliostats focus concentrated sunlight on a receiver which sits on top of the tower. Within the receiver the concentrated sunlight heats molten salt to over 1,000 F

(538 C). The heated molten salt then flows into a thermal storage tank where it is stored, maintaining 98% thermal efficiency, and eventually pumped to a steam generator. The steam drives a standard turbine to generate electricity. This process, also known as the "Rankine cycle" is similar to a standard coal-fired power plant, except it is fueled by clean and free solar energy.

The advantage of this design above the parabolic trough design is the higher temperature. Thermal energy at higher temperatures can be converted to electricity more efficiently and can be more cheaply stored for later use. Furthermore, there is less need to flatten the ground area. In principle a power tower can be built on the side of a hill. Mirrors can be flat and plumbing is concentrated in the tower. The disadvantage is that each mirror must have its own dual-axis control, while in the parabolic trough design single axis tracking can be shared for a large array of mirrors.

A cost/performance comparison between power tower and parabolic trough concentrators was made by the NREL which estimated that by 2020 electricity could be produced from power towers for 5.47 /kWh and for 6.21 /kWh from parabolic troughs. The capacity factor for power towers was estimated to be 72.9% and 56.2% for parabolic troughs. There is some hope that the development of cheap, durable, mass producible heliostat power plant components could bring this cost down.

The first commercial tower power plant was PS10 in Spain with a capacity of 11 MW, completed in 2007. Since then a number of plants have been proposed, several have been built in a number of countries (Spain, Germany, U.S., Turkey, China, India) but several proposed plants were cancelled as photovoltaic solar prices plummeted. A solar power tower went online in South Africa in 2016. Ivanpah Solar Power Facility in California generates 392 MW of electricity from three towers, making it the largest solar power tower plant when it came online in late 2013.

4.4.3 Dish Collector

A dish Stirling or dish engine system consists of a stand-alone parabolic reflector that concentrates light onto a receiver positioned at the reflector's focal point. The reflector tracks the Sun along two axes. The working fluid in the receiver is heated to 250–700 C (482–1,292 F) and then used by a Stirling engine to generate power. Parabolic-dish systems provide high solar-to-electric efficiency (between 31% and 32%), and their modular nature provides scalability. The Stirling Energy Systems (SES), United Sun Systems (USS) and Science Applications International Corporation (SAIC) dishes at UNLV, and Australian National University's Big Dish in Canberra, Australia are representative of this technology. A world record for solar to electric efficiency was set at 31.25% by SES dishes at the National Solar Thermal Test Facility (NSTTF) in New Mexico on 31 January 2008, a cold, bright day. According to its developer, Ripasso Energy, a Swedish firm, in 2015 its Dish Sterling system being tested in the Kalahari Desert in South Africa showed 34% efficiency. The SES installation in Maricopa, Phoenix was the largest Stirling Dish power installation in the world until it was sold to United Sun Systems. Subsequently, larger parts of the installation have been moved to China as part of the huge energy demand.

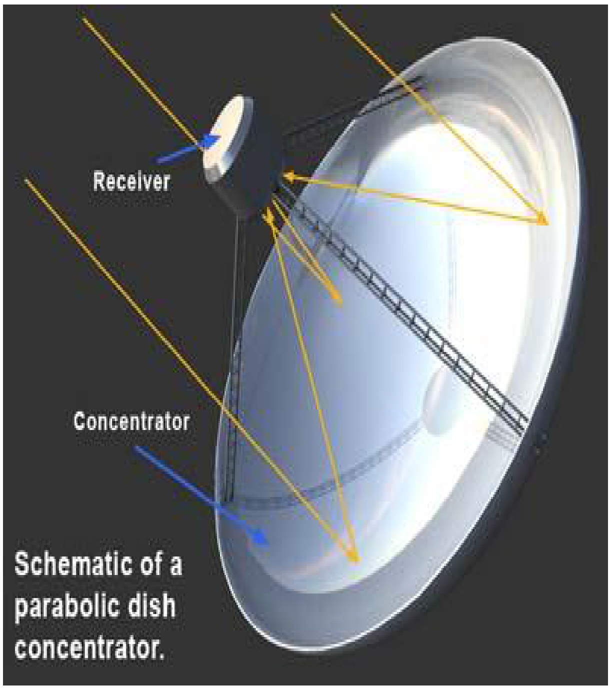


Figure 4.8: Dish Collector

4.5 Absorber

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Figure 4.9: Absorber

Absorber is a device which absorb the concentrated heat. Absorber Absorb the heat and converted it to another form of energy. Here we are using Thermocouple as a absorber. With Thermocouple we also using liquid to pass through absorber. Absorber absorb the heat energy in two forms i.e. Electric Heat storage using liquid. Absorber consist of lots of thermocouple connected in series.

Basically Absorber is a hollow metallic tube. The hollow tube is useful to pass liquid through it. The liquid is get heated or get vaporise.

4.6 Pumping System

Pumping System include the motors and tanks. Tanks which stores the liquid. There is Tanks, One is to store the cool liquid another is for hot liquid. Pump system Pump the liquid through absorber.

Figure 4.10: Pumping Motor

Pumping system uses motors to pump liquid. This system is very useful and controller by the controller or manually. It sense the temperature of hot liquid and decide the flow of liquid.Solar water pumps are an effective alternative to conventional gas, diesel or electric pumps. The pumps are powered by solar energy effectively, and are often used for irrigation and drinking water. Solar water pumping systems use solar energy to pump water. The systems offer very high reliability, minimum maintenance and a long service life. The biggest advantage of solar pumps is that there are no running costs except for maintenance.

4.7 Gear

Figure 4.11: Gear

A gear or cogwheel is a rotating machine part having cut teeth or, in the case of a cogwheel, inserted teeth (called cogs), which mesh with another toothed part to transmit torque. Geared devices can change the speed, torque, and direction of a power source. Gears almost always produce a change in torque, creating a mechanical advantage, through their gear ratio, and thus may be considered a simple machine. The teeth on the two meshing gears all have the same shape.Two or more meshing gears, working in a sequence, are called a gear train or a transmission. A gear can mesh with a linear toothed part, called a rack, producing translation instead of rotation. The gears in a transmission are analogous to the wheels in a crossed, belt pulley system. An advantage of gears is that the teeth of a gear prevent slippage.

4.8 Pillow Block Bearing

Figure 4.12: Pillow Block Bearing

A pillow block bearing consists of a mounting bracket (pillow block) that houses a bearing and is used in low-torque, light load applications.

With this configuration, the pillow block is bolted to a foundation, securing it, while the shaft and the inner ring of the bearing are free to rotate. Usually made of gray cast iron, pillow blocks come in two types, split or unsplit. With split pillow blocks the housing element or cap can be separated from the base. An unsplit pillow block is made from one solid piece.Often, the terms pillow block bearing and plumber block bearing are used synonymously but the two are different devices. Both are designed to be mounted to a surface through mounting holes on the base of the block. They differ in that plumber block bearings do contain an inner bearing and they are also designed for higher loads and more corrosive environments.

4.9 Bright Bar

Bright bars are steel bars which are geometrically in precise shape and have tolerance which is tight dimensional. Its surface finish is smooth and shiny, which appears to be bright. Bright steel bars have several uses and applications. Bright bars are available in rounds, flats, hexagonal and squares.

These bars are crafted in many grades and different process of manufacturing is used depending on the form of application and designs. Bright bars are manufactured in ultimate quality, which is why they are so popular with our clients. We produce Industrial grade bright bars in Carbon steel, Mild steel, Case nitriding and hardening, Micro alloyed, alloy steel, graded steel, free cuts which are carbon free or customized bright bars according to client's requirement.

Figure 4.13: Bright Bar

Our steel plant is fitted with ultra modern production technologies which go through modern processes of making steel. High quality manufacturing process teamed up with modern facilities has provided us the reputation of being top-rate manufacturers and exporters in the country.Bright steel bar is usually a carbon steel alloy which has had the surface condition improved by drawing, peeling or grinding over the hot rolled finish supplied by the steel mill. Advantages achieved include improved machining, less wastage at component production stage, enhancement of physical and mechanical properties and improved dimensional tolerances and straightness.

4.10 Hollow Pipe

Circular hollow sections, also known as round steel tubes, are a common type of steel section that is used in a variety of formats over various industries in South Africa.

These steel sections are rolled from steel sheet or slit coil. The slit strip of steel coil goes through a forming and sizing section in a normal cold forming steel mill. The mill consists of a number of passes through which the sheet is gradually formed, each pass bending the steel sheet more and changing the radii on each pass. This is done until the two ends of the steel is pressed together and then welded inline.

Round steel sections can be rolled from a variety of materials. Most common is hot and cold rolled steel tubes. Hot rolled sections are predominantly used for structural purposes while tubes rolled from cold rolled steel has better bending ability and gives a better aesthetic appearance after being powder coated. Steel sections can also be fin

Figure 4.14: Hollow Pipe

controlled and internally scarfed. A tube that is fin controlled means that the internal weld bead of the section has been controlled to an absolute minimum while a scarfed steel tube had the weld bead removed inline. This allows the tube to be suitable for mandrel bending.

Drawn steel sections and precision drawn steel tubes plays a large part in the steel industry. Steel sections can be drawn from a standard available sized tube to a smaller sized steel section. With precision drawn tubes the inner diameter of the steel tube can be controlled using a mandrel while the outer diameter is drawn down through a die.

4.11 Glass

Elastically deforming thin glass provides an alternate method of forming a curved glass reflector which can eliminate some of the disadvantages of thicker glass. This paper describes a concept where silvered thin glass is bonded to a steel backing to form a laminate with a reflectance greater than 93 percents.Subsequent bending of the flat reflector laminate to a concentrating profile produces compressive stresses throughout the glass if the laminate is properly designed. These compressive stresses enhance fracture resistance and the lamination provides protection for the silver. The design of the laminate is outlined for 0.25 and 0.51 mm thickness glass and fabrication procedures are discussed. Thermal/humidity cycling, hail impact, bond strength measurements and reflectance results are presented which demonstrate the performance capabilities of this reflector laminate concept.

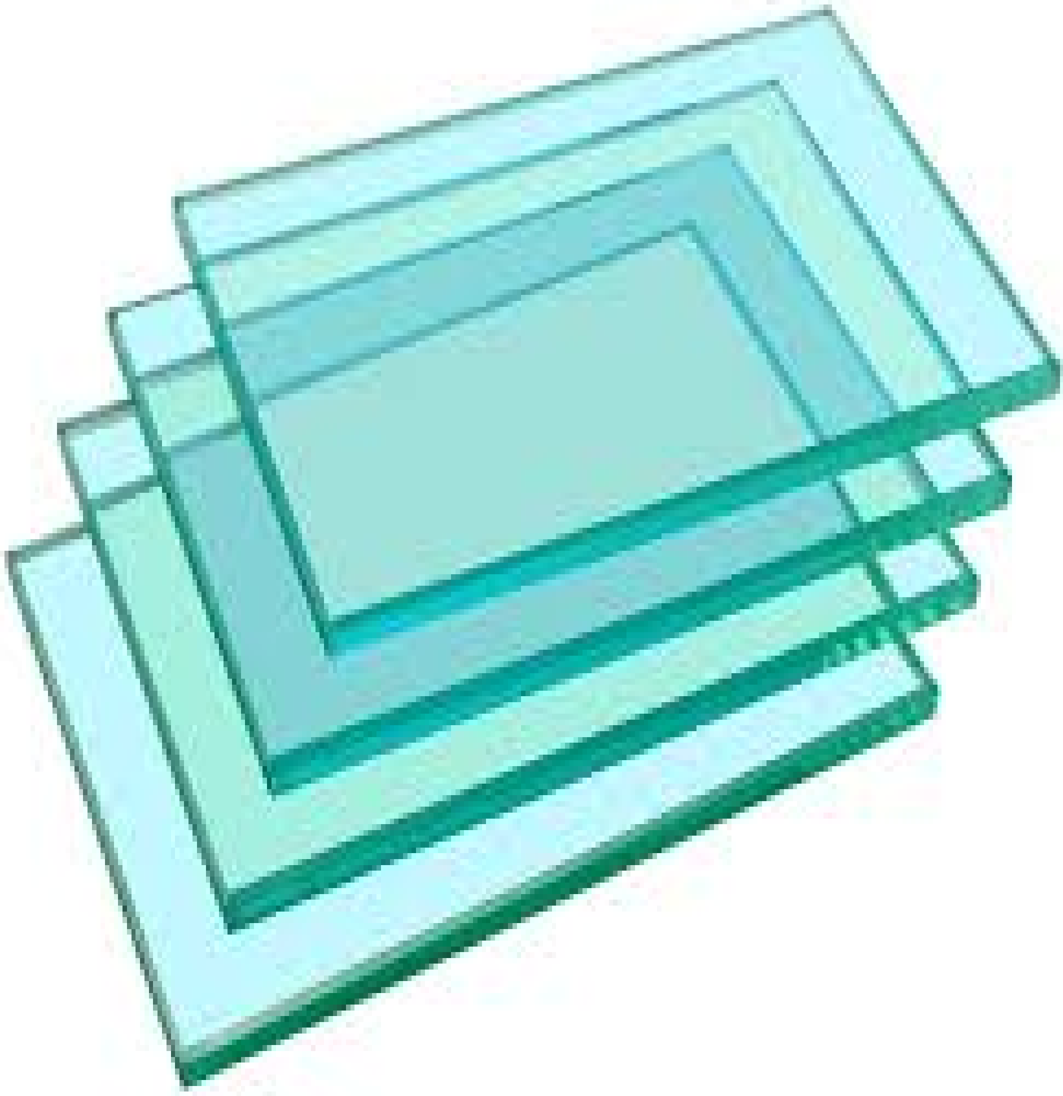

Figure 4.15: Glass

4.12 Thermocouple

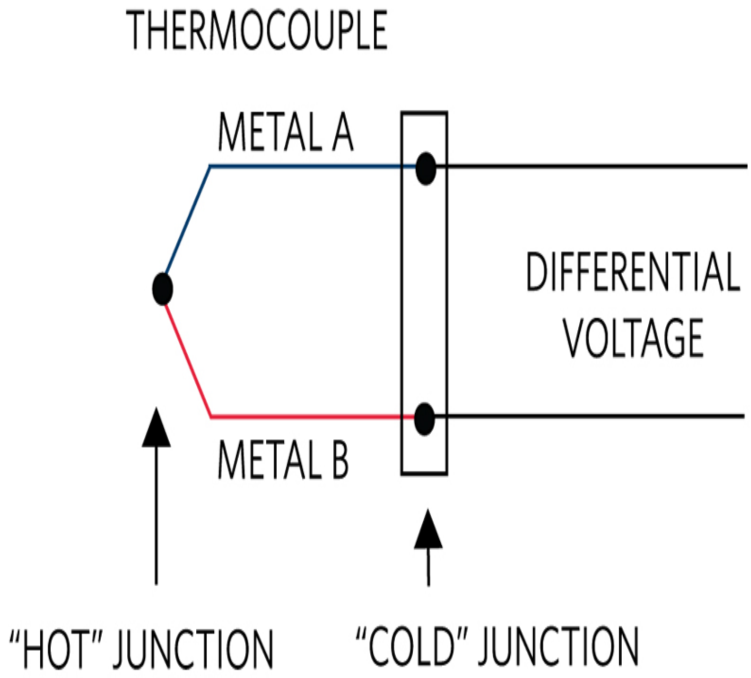

Figure 4.16: Thermocouple

A Thermocouple is a sensor used to measure temperature. Thermocouples consist of two wire legs made from different metals. The wires legs are welded together at one end, creating a junction. This junction is where the temperature is measured. When the junction experiences a change in temperature, a voltage is created. The voltage can then be interpreted using thermocouple reference tables to calculate the temperature.

There are many types of thermocouples, each with its own unique characteristics in terms of temperature range, durability, vibration resistance, chemical resistance, and application compatibility. Type J, K, T, E are "Base Metal" thermocouples, the most common types of thermocouples.Type R, S, and B thermocouples are "Noble Metal" thermocouples, which are used in high temperature applications (see thermocouple temperature ranges for details) Thermocouples are used in many industrial, scientific, and OEM applications. They can be found in nearly all industrial markets: Power Generation, Oil/Gas, Pharmaceutical, BioTech, Cement, Paper Pulp, etc. Thermocouples are also used in everyday appliances like stoves, furnaces, and toasters.

Thermocouples are typically selected because of their low cost, high temperature limits, wide temperature ranges, and durable nature.

4.13 Arduino

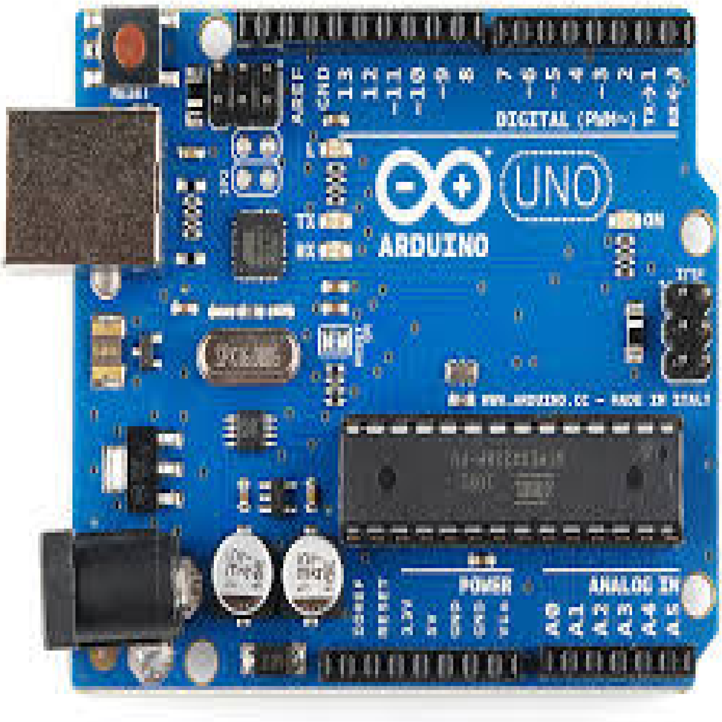

Figure 4.17: Arduino

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do so you use the Arduino programming language (based on Wiring), and the Arduino Software (IDE), based on Processing. Over the years Arduino has been the brain of thousands of projects, from everyday objects to complex scientific instruments. A worldwide community of makers - students, hobbyists, artists, programmers, and professionals - has gathered around this open-source platform, their contributions have added up to an incredible amount of accessible knowledge that can be of great help to novices and experts alike.

Arduino was born at the Ivrea Interaction Design Institute as an easy tool for fast prototyping, aimed at students without a background in electronics and programming. As soon as it reached a wider community, the Arduino board started changing to adapt to new needs and challenges, differentiating its offer from simple 8-bit boards to products for IoT applications, wearable, 3D printing, and embedded environments. All Arduino boards are completely open-source, empowering users to build them independently and eventually adapt them to their particular needs. The software, too, is open-source, and it is growing through the contributions of users worldwide.

4.14 INVERTER

A power inverter, or inverter, is a power electronic device or circuitry that changes direct current (DC) to alternating current (AC).

The input voltage, output voltage and frequency, and overall power handling depend on the design of the specific device or circuitry. The inverter does not produce any power; the power is provided by the DC source.

A power inverter can be entirely electronic or may be a combination of mechanical effects (such as a rotary apparatus) and electronic circuitry. Static inverters do not use moving parts in the conversion process.

Power inverters are primarily used in electrical power applications where high currents and voltages are present; circuits that perform the same function for electronic signals, which usually have very low currents and voltages, are called oscillators. Circuits that perform the opposite function, converting AC to DC, are called rectifiers.

Figure 4.18: Solar Inverter

Input

A typical power inverter device or circuit requires a relatively stable DC power source capable of supplying enough current for the intended power demands of the system. The input voltage depends on the design and purpose of the inverter. Examples include:
12 V DC, for smaller consumer and commercial inverters that typically run from a rechargeable 12 V lead acid battery or automotive electrical outlet.
24, 36 and 48 V DC, which are common standards for home energy systems.
200 to 400 V DC, when power is from photovoltaic solar panels.
300 to 450 V DC, when power is from electric vehicle battery packs in vehicle-to-grid systems.
Hundreds of thousands of volts, where the inverter is part of a high-voltage direct current power transmission system.

4.14.1 Solar Batteries

Solar batteries are C10 rating deep cycle battery designed for connecting with solar charge controllers, inverters for giving power backup at night. It is designed to be charged from Solar panels in the day from sunlight. The main component of battery is the lead inside it. Higher lead ensures better battery performance and quality. Lead acid batteries are not sealed and Maintenance free hence it requires water top up once in 3-6 month.

How to Choose Solar Battery

1) Battery Capacity measured in Ah (Ampere-hour)

2) Battery warranty

3) Price, depends on Battery Ah and warranty.

There are two types of battery:

a) Flat Plate battery
b) Tubular battery
There is no much difference in these technology type batteries except warranty and life. The height of battery determines the technology type, Tubular means tall battery and flat plate means short height battery.

Figure 4.19: Solar Battery

Chapter 5

CALCULATION

5.1 S.S Sheet

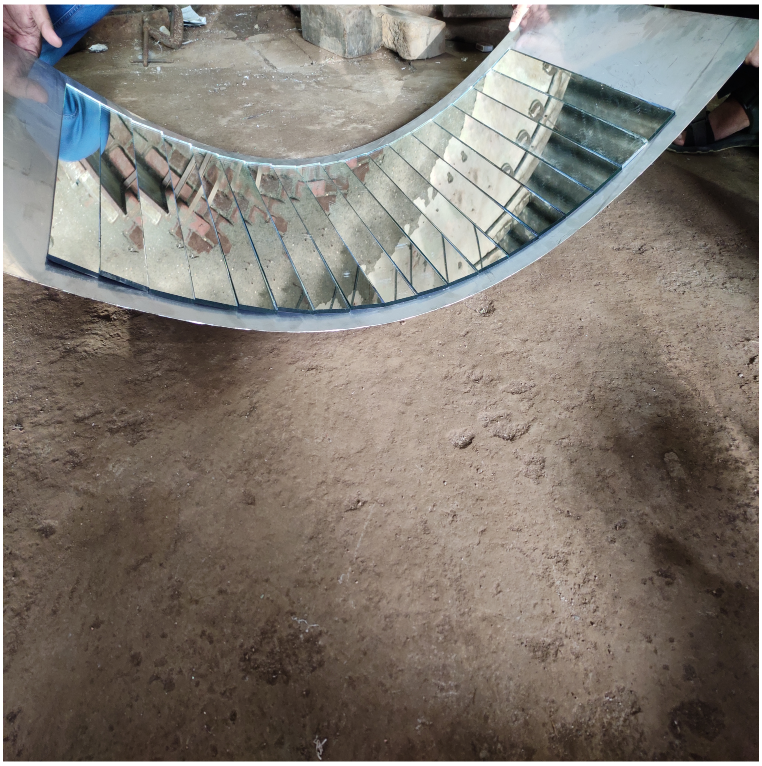

Figure 5.1: Parabolic Concentrator

Thickness = 1mm

Height = 33cm

Aperature = 90cm

$$H = A^2/16F \tag{5.1}$$

$$F = A^2/16H \tag{5.2}$$

A = Aperature Of Reflectior

H = Height Of Reflector

F = Focal Length Of Reflector

5.2 Glass

Height of Glass = 6ft

Width of Glass = 1.2ft

used piece :- 1.5inch * 1.2ft

Chapter 6

ADVANTAGES AND DISADVANTAGES

6.1 Advantages

1. It helps in reducing the cost by replacing an expensive large receiver by a less expensive reflecting or refracting area.
2. Due to concentration on a smaller area, the heat loss area is reduced.
3. Further the thermal mass as much smaller than that of a flat plate collector and hence transient effects are small.
4. The delivery temperature being high, a thermodynamic match between the temperature level the task occurs.
5. It increases the intensity by concentrating the energy available over a large surface onto a smaller surface (absorber).

6.2 Disadvantages

1. Non uniform flux on absorbers.
2. Maintenance is high.
3. Wide variation in shape.
4. Higher the concentration of the collector, higher is the precision of optics and more is the cost of the unit.

Chapter 7

APPLICATION

1. Cooking
2. Water heating
3. Process heat
4. Water treatment
5. Power generation
6. Cooling and air-conditioning.
7. Steam generation (for electricity power-plants).
8. Desalination of sea water.
9. Production of hot water for domestic and industrial use.
10. Production of hydrogen gas.

Chapter 8

FUTURE SCOPE

A study done by Greenpeace ICooking 2. Water heating 3. Process heat 4. Water treatment 5. Power generationnternational, the European Solar Thermal Electricity Association, and the International Energy Agency's SolarPACES group investigated the potential and future of concentrated solar power. The study found that concentrated solar power could account for up to 25% of the world's energy needs by 2050. The increase in investment would be from 2 billion worldwide to 92.5 billion in that time period. Spain is the leader in concentrated solar power technology, with more than 50 government-approved projects in the works. Also, it exports its technology, further increasing the technology's stake in energy worldwide. Because the technology works best with areas of high insolation (solar radiation), experts predict the biggest growth in places like Africa, Mexico, and the southwest United States. It indicates that the thermal storage systems based in nitrates (calcium, potassium, sodium,...) will make the CSP plants more and more profitable. The study examined three different outcomes for this technology: no increases in CSP technology, investment continuing as it has been in Spain and the US, and finally the true potential of CSP without any barriers on its growth.

Year	Annual Investment	Cumulative Capacity
2015	21 billion	4,750 MW
2050	174 billion	1,500,000 MW

Table 8.1: CSP Investment and Capacity

Finally, the study acknowledged how technology for CSP was improving and how this would result in a drastic price decrease by 2050. It predicted a drop from the current range of 0.23–0.15/kWh to 0.14–0.10/kWh.

The European Union looked into developing a 400 billion (US$774 billion) network of solar power plants based in the Sahara region using CSP technology to be known as Desertec, to create "a new carbon-free network linking Europe, the Middle East and North Africa". The plan was backed mainly by German industrialists and predicted production of 15% of Europe's power by 2050. Morocco was a major partner in Desertec and as it has barely 1% of the electricity consumption of the EU, it could produce more than enough energy for the entire country with a large energy surplus to deliver to Europe. Algeria has the biggest area of desert, and private Algerian firm Cevital signed up for Desertec. With its wide desert (the highest CSP potential in the Mediterranean and Middle East regions about 170 TWh/year) and its strategic geographical location near Europe, Algeria is one of the key countries to ensure the success of Desertec project. Moreover, with the abundant natural-gas reserve in the Algerian desert, this will strengthen the technical potential of Algeria in acquiring Solar-Gas Hybrid Power Plants for 24-hour electricity generation. Most of the participants pulled out of the effort at the end of 2014.

Other organizations had predicted CSP to cost $0.06(US)/kWh by 2015 due to efficiency improvements and mass production of equipment. That would have made CSP as cheap as conventional power. Investors such as venture capitalist Vinod Khosla expect CSP to continuously reduce costs and actually be cheaper than coal power after 2015.

In 2009, scientists at the National Renewable Energy Laboratory (NREL) and SkyFuel teamed to develop large curved sheets of metal that have the potential to be 30% less expensive than today's best collectors of concentrated solar power by replacing glass-based models with a silver polymer sheet that has the same performance as the heavy glass mirrors, but at much lower cost and weight. It also is much easier to deploy and install. The glossy film uses several layers of polymers, with an inner layer of pure silver.

Telescope designer Roger Angel (Univ. of Arizona) has turned his attention to CPV, and is a partner in a company called Rehnu. Angel utilizes a spherical concentrating lens with large-telescope technologies, but much cheaper materials and mechanisms, to create efficient systems.

Experience with CSP technology in 2014-2015 at Solana in Arizona, and Ivanpah in Nevada indicate large production shortfalls in electricity generation between 25% and 40% in the first years of operation. Producers blame clouds and stormy weather, but critics seem to think there are technological issues. These problems are causing utilities to pay inflated prices for wholesale electricity, and threaten the long-term viability of the technology. As photovoltaic costs continue to plummet, many think CSP has a limited future in utility-scale electricity production.

China plans to have a total capacity of 5.3 GW of load following CSP power plants by 2022. By 2018, the LCOE of CSP with 15 hours storage in China has fallen to 0.1 US$/kWh. China has reposed confidence in CSP technology for meeting its energy needs and taken global leadership to make CSP commercially competitive over other dispatchable generation.[102] CSP with thermal storage has clear advantage in cogeneration and heating applications (process steam generation, etc) as it can operate continuously at high efficiency.

CSP has other uses than electricity. Researchers are investigating solar thermal reactors for the production of solar fuels, making solar a fully transportable form of energy in the future. These researchers use the solar heat of CSP as a catalyst for thermochemistry to break apart molecules of H2O, to create hydrogen (H2) from solar energy with no carbon emissions. By splitting both H2O and CO2, other much-used hydrocarbons – for example, the jet fuel used to fly commercial airplanes – could also be created with solar energy rather than from fossil fuels.

Chapter 9

WORK DONE TILL DATE

Figure 9.1: Parabolic Concentrator

Figure 9.2: Dish Concentrator

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