"Solar Stirling Plant to Produce Electricity"

[1]Firdous Tahseen, [2]Channabasappa M, [3]Sheethal R, [4]Mrs. Sushmitha Deb

[1,2,3]U.G Students, [4]Assistant Professor
EEE Dept, SJMIT, Chitradurga, Karnataka, India

***Abstract*- Solar Stirling Plant is a far more effective and efficient means of producing electrical energy. Unlike the standard PV panels, the Solar Stirling Plant is by wide margin easier and cheaper to build and at the same time more effective at harnessing the solar energy from the sun. It is mind blowing concept when you actually consider that the sun produces enough energy everyday to sustain the average households electrical needs by constructing the plant which produces enough energy. The amount of solar energy that we use today is no way affects the amount of energy that will be available for use tomorrow or in twenty years. Even better thing is we are not borrowing future energy or creating any threat to environment. The very time of our life is electricity dependent. The pay for the bill has increased due to complete dependency. This could be curtailed by generating our own energy which can be stored and utilized. The overall importance lies in producing our own electrical energy and cut down our pay for electrical companies. These power plants meet the electrical needs of villages, hospitals, lodges etc., besides production of electricity for the grid.**

I. INTRODUCTION

Stirling engine is an external combustion engine, offers potential advantages over conventional engines in fuel choices, noise and emissions. Multi-fuels such as agricultural by-product, biomass, bio-diesel, solar energy and etc., can be employed as a heat source for a stirling engine. This report describes production of electricity using solar powered stirling engine which utilizes solar energy as a heat source. The solar dishes are mounted as parabolic solar collectors with mirrors. As the parabolic dish collects the heat from the source, start up the engine, which is coupled to the dc generator delivers the electricity flow to the load.

Stirling engine operates by cyclic compression and expansion of air at different temperatures such that there is net conversion of heat energy to mechanical work. More specifically it is a closed cycle regenerative heat engine with permanent working of gas which is sealed in the engine. Closed cycle in this context means a thermodynamic system in which the working gas is permanently contained within the system and regenerative describes the use of a specific type of internal heat exchanger.

Fossil fuels are the crucial energy that provide power and meet requirements. The limitation of fossil fuels leads to fuel price crisis. Emissions from energy consumptions causes pollution and leads to global warming. It is very important and necessary to search renewable and alternative energy for sustained power generation. Solar energy is free and available energy to be converted to useful power. Stirling engine, first discovered by Robert Stirling in 1816. It is a CHP system, heated by solar energy and it works perfectly and at high efficiency, when sufficient heat is supplied compared that with other solar energy converters such as solar cell or photovoltaic cell.

II. COMPONENTS

A. Parabolic Reflector

A parabolic reflector focus the Sun's radiation to a particular point. Mirrors are used as reflectors of 6mm thickness. The size of the dish is (1000*1000)mm with 10cm depth. Metal rods are soldered in a tripod shape to hold the Stirling Engine and DC Generator as shown in the fig 1

Fig.1

The whole reflector dish is made to fix upon the metal stand and it can be rotated for an angle of 180 degree.

B. Alpha Stirling Engine

A stirling engine is a heat engine that operates by cyclic compression and expansion of air or other gas (the working fluid) at different temperatures, such that there is a net conversion of heat energy to mechanical work. More specifically, the stirling engine is a closed cycle regenerative heat engine with a permanently gaseous working fluid. Closed cycle , in this context, means a thermodynamic system in which the the working fluid is permanently contained within the system, and regenerative describes the use of a specific type of internal heat exchanger and thermal store, known as regenerator. The inclusion of a regenerator differentiates the stirling engine from other closed cycle hot air engine.

Originally conceived in 1816 as an industrial prime mover to rival the steam engine, its practical use was largely

confined to low-power domestic applications for over a century.

Stirling engine have a high efficiency compared to steam engines, being able to reach 50% efficiency. They are also capable of quiet operation and can use almost any heat source is generated external to the Stirling engine rather than by internal combustion as with the Otto cycle or Diesel cycle engines. Because the stirling engine is a compatible with alternative and renewable energy sources it could become increasingly significant as the price of conventional fuels rises, and also in light of concerns such as depletion of oil supplies and climate change.

Stirling engines are classified into three types with view point of working space namely., Alpha type, Beta type and Gamma type.

Fig.2

An Alpha type contains two separate power pistons in separate cylinders, one hot piston and cold piston. The hot piston cylinder is situated inside the higher temperature heat exchanger and the cold piston cylinder is situated inside the low temperature heat exchanger.

The specification of this engine are polished grade aluminum wheel, anodized piston, brass sleeve, temperature withstand glass wot part of the engine.

The dimension of the engine are as follows: height = 10.9cm, width = 6cm, length 14.7cm, weight = 0.285kg

C KEY COMPONENTS OF THE ENGINE

1. Heater / hot side heat exchanger

It is the cylindrical part where its base is placed at the focus point. This part should get heated up to expand the working fluid (air) which is sealed between this heater and another cooler. It is made up of glass.

2. Regenerator

It is an internal heat exchanger in temporary heat store placed between the hot and cold places such that the working fluid passes through it first in one direction then the other, taking heat from the fluid in one direction, and returning it in the other. It is a pipe connecting the heater and cooler..

3. Cooler/ cold side heat exchanger

The cooler is at ambient temperature, the hot air when comes into this cylinder heat flows from air to this part causing the air to get decreased in size as the gas molecules releases its heat.

4. Power pistons

Two pistons each one present in heater and cooler are called power pistons. Both pistons are connected to each other and to the flywheel through crankshaft. Each piston is delayed by one by fourth of the cycle.

5. Flywheel

Flywheel is the part where the rotational output that is mechanical energy is obtained. Its made up of stainless steel. But for the engine to start up after the gain of sufficient temperature, manual rotation is given to it.

D. Working of Alpha Stirling Engine

The hot part of the engine is placed at the focus point. After the sufficient heat gain to the working fluid, initially manual start up rotation is given to the flywheel. Upon which the engine starts to run. Air inside the hot part which has been expanded moves to the cold part when piston is moved, due to external rotation of the flywheel. At the cold part the air losses its heat and get compressed and moves back to the hot part through regenerator due to back and forth movement of the pistons. Both pistons are delayed by one fourth of the cycle. The cyclic expansion and compression of the working fluid takes place as long as the required temperature is given which keeps the flywheel rotating.

E. DC Generator

A DC generator produces direct power. It works based on the fundamental principle of Faraday's law of electromagnetic induction. According to this law, when a conductor moves in a magnetic field it cuts magnetic lines force, due to which an emf is induced in the conductor. The magnitude of induced emf depends upon the rate of change of flux (magnetic lines of force) linking with the conductor.
A DC Generator of 6V rating is used which is shown in the fig 3

Fig.3

F. Incandescent Bulb

An incandescent bulb of 6V is used to know the flow of electricity. It is having a size of a thumb.
It is shown in the fig 4. An incandescent bulb typically consists of a glass enclosure containing a tungsten filament.

An electric current passes through the filament, heating it to a temperature that produces light.

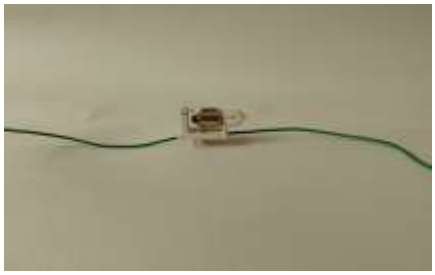


Fig. 4

III. PROPOSED METHODOLOGY

Fig. 5

The components are connected as shown in the fig 6

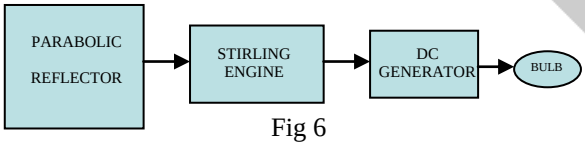


Fig 6

Practically constructed model is as shown in the fig 5

At the focus point hot part of the engine is fixed. Its flywheel is coupled to the generator as in fig 7

After sufficient temperature it is made to rotate manually. The flywheel in turn rotates the generator. To know the flow of electricity, generator is connected to the incandescent bulb.

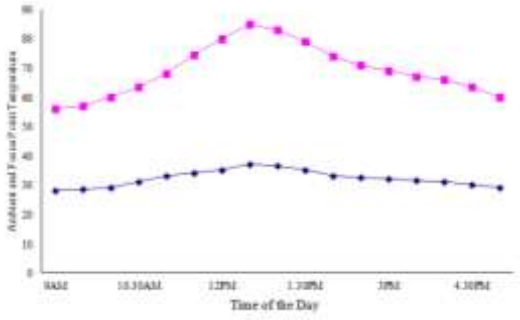
At particular interval of time, ambient temperature, focus point temperature, rotation of the flywheel and the rotor generator values are measured. And using multi meter generated voltage is measured.

TIME	AMBIENT TEMPERATURE (degree Celsius)	TEMPERATURE AT THE FOCUS POINT(degree Celsius)	SPEED OF THE ENGINE(rpm)	SPEED OF THE DC GENERATOR(rpm)	VOLTAGE OF THE DC GENERATOR(V)
9.00AM	28.00	56.00	_-	-	-
9.30AM	28.50	57.00	-	-	-
10.00AM	29.00	60.00	-	-	-
10.30AM	31.00	63.50	-	-	-
11.00AM	33.00	69.50	24.50	1607.2	1.58
11.30AM	34.00	74.50	60.50	3968.8	3.77
12.00PM	35.00	80.00	81.50	5346.4	5.08
12.30PM	37.00	85.00	91.50	6002.4	5.70
1.00PM	36.50	83.00	88.00	5771.8	5.48
1.30PM	35.00	79.00	78.00	5116.8	4.86
2.00PM	33.00	74.00	60.00	3936.0	3.74
2.30PM	32.50	71.00	45.00	3776.4	2.30
3.00PM	32.00	69.00	25.00	1640.0	1.56
3.30PM	31.50	67.00	-	-	-
4.00PM	31.00	66.00	-	-	-
4.30PM	30.00	63.50	-	-	-
5.00 PM	29.00	60.00	-	-	-

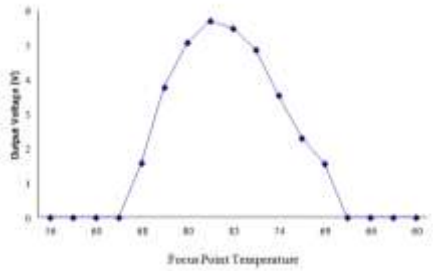
IV. RESULTS AND ANALYSIS

A. Graphical Analysis

1. Time of the Day versus Ambient Temperature and Temperature at the Focus Point



2. Focus Point Temperature versus output voltage



B. Observations

- Stirling engine starts its operation at 69.5 degree Celsius at 11.00am giving output voltage of 1.58volts.
- As the temperature increases the rotational speed increases as given in table 1.
- At maximum ambient temperature of 37 degree Celsius at 12.30pm we get 85 degree Celsius at the focus point.
- At the highest temperature the engine runs at 91.5 rpm and dc generator at 6002.4 (since the flywheel of the engine has greater diameter than that of the d c generator) giving maximum voltage of 5.7volts

V. FUTURE SCOPE

- On a medium large scale electricity generation: Highest efficiency can be obtained on commercial, practical solar electricity technologies with reasonable area and investment
- For Industries: Industries could produce green and clean power. Each unit can generate from 10KW to 1MW. But area required per kilowatt depends on temperature profile of the region, specification of engine.
- On a small scale for home and buildings: These systems are better than PV systems. When set up along with original power lines they could be taken as back up lines. Which could give 24 hours of electricity.
- In Agriculture: The latest break-through is Solar Stirling Water pumps that could lift the water in farm fields and stops farmers wait for electricity.

VI. CONCLUSION

A new era in harnessing solar energy has begun. These engines are the potential source of solar electricity. Many countries have already invested in this technology and are reaping the twin benefits of nation development and environment fortification. The solar thermal potential India remains undiscovered few estimates that it might even be few giga watts. After two centuries of their invention stirling engines are now put to their full fledged applications.

VII. REFERENCES

[1] Prof. U.S.P. Shet , Prof. T. Sundararajan and Prof. J.M . Mallikarjuna, IITM “Gas Power Cycles”.
[2] International Energy Agency (2012). "Energy Technology Perspectives 2012".
[3] REN21 (2014). "Renewables 2014: Global Status Report".
[4] "Power from Sunshine": A Business History of Solar Energy.
[5] "Solar Energy Perspectives: Executive Summary" International Energy Agency.

VIII. BIOGRAPHY

[1]

Firdous Tahseen, U.G student ,EEE
Dept.,SJMIT, Chitradurga,
Karnataka, India

[2]

Channabasappa M,U.G student,EEE
Dept.,SJMIT, Chitradurga,
Karnataka, India

[3]

Sheethal.R, U.G student,EEE
Dept.SJMIT Chitradurga ,
Karnataka, India

[4]

Mrs. Sushmitha Deb presently working as Assistant Professor in Dept. of EEE, SJMIT, ChitradurgaKarnataka, India.
Completed B.Tech (EEE) in the year 2006 from SMIT, Sikkim and M.Tech (Power Electronics) in 2011 from SMIT, Sikkim. Areas of interest is Power Electronics, Digital Electronics, Power System..