Analysis of solar assisted steam generation using various concentrators

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ABSTRACT

Solar energy is a primary type of energy which is present in nature. It is a permanent, non-polluting and low running cost form of energy. It can be used for various domestic and agriculture requirements including cooking, drying, dehydration, heating, cooling and electricity production. In the present scenario of energy crises an alternate cooking solution is using renewable energy sources like solar energy and biogas is inevitable. The object of this paper is to analysis various solar concentrator which are used for production of steam and this steam is used for cooking and various purpose.

KEYWORDS

Solar energy, concentrators, performance, tracking system.

I.

UCTION

INTROD

The last few years, we have seen that use of Solar Energy is emerging in our day to day life. Earth receives 174000 TW of solar radiations per year. The total solar energy absorbed by earth's atmosphere, ocean and land is approximately 3850000 ExaJoules (EJ) per year. Solar energy is utilize using conventional PV cells and concentrated solar power. A decade ago use of both rooftop solar energy and photovoltaic power began to accelerate due to supply issues of oil, natural gas and other conventional energy sources and also due to global warming concerns. That time solar energy is used only for Miss. Sneha Mandhre

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boiling water, cooking purpose using small solar cooker and electricity production using PV cells, cooling purpose etc. Current scenario is, this solar energy use in architecture and urban planning, transport, agriculture etc.

Majority of world's electricity is produced using conventional energy sources like coal, oil, natural gas, fissile and fertile materials. These conventional sources faces challenges including increase in price, availability and environmental concerns. Because of this governments, businessmen and consumers are supporting alternating energy sources Renewable energy sources for generation of electricity. Solar power generation has emerged as one of the renewable energy source. It generates electricity without any environmental impact as compare to other energy sources. It can be installed at consumer's site which reduces production investment and transportation infrastructure.

Variety of fuel like wood, gas, coal, kerosene is used for cooking purpose. But their cost is increasing day by day and they are contributing more in global warming. Solar is use to produce steam from water using concentrated reflectors. Solar concentrators are used to collect and concentrate sun's rays to heat up a working fluid to required temperature. This steam is mostly use for cooking purpose and other applications. It includes food processing, producing drinking water from sea water etc. But the time and men power required for cooking is more. The solution for these problem is to use solar energy

Time in Hour	Outlet	Outlet
	temperature for	temperature for
	aluminum	galvanized iron
	sheet in °C	sheet in °C
9.30 AM	68.1	45.2
10.30 AM	82.1	51.2
11.30 AM	100.4	52.7
12.30 PM	127.7	64.4
1.30 PM	140.2	75.1
2.30 PM	120.5	65.4
3.30 PM	100.7	61.7
4.30 PM	85.8	52.5

steam cooking which uses thermal energy of sun for generation of heat. Work is in progress to use this technology in textile industry, pharmaceuticals, dairy, chemical industry, paper industry etc. It also use in VAM (Vapour Absorption Machines) for airconditioning and chilling applications.

II. ANAYLISIS OF VARIOUS SOLAR CONCENTRATORS:

1. PARABOLIC TROUGH-

Parabolic trough consist of linear parabolic reflector which concentrates sunlight on receiver position along the reflectors centric line. Parabolic trough creates temperature upto 150-400 °C in working fluid which produces heat and this heat is used in various energy generation. This is most commercialized & is good for hybrid option. The efficiency of the receiver is good but that of turbine is low.

[1]



Fig1. Schematic diagram of Parabolic trough

COMPARISING VARIOUS REFLECTOR SHEETS:

Table1. comparison of various reflecting sheets

IMPROVEMENTS:

When one end of the trough is turned, the other remains stationary. This causes the mirror frame to rotate, and this is the reason the reflective aluminum is never damaging the material



Fig2. Outlet temperature vs. time

Initially efficiency decreases and increases. By using aluminum sheet as reflector, efficiency of galvanized sheet is lesser as compared to reflector. So it can be said that aluminum sheet can be used for cooking purpose.

2. FRESNEL REFLECTORS-

Fresnel reflector consist of thin, flat and long mirror strips to focus sunlight onto common point of reflector where absorber is mounted to absorbs sunlight. These mirrors concentrate sun's energy approximately 30 times greater than its normal intensity. Then thermal fluid is heated using this concentrated energy. Thermal fluid goes through heat exchanger to produce steam. This steam is used in various energy generation. The operating temperature

is about 700-800° C. It uses line focusing type . The concentrators used are flat or curved concentrator mirrors. This system is commercially under development.[2]



Fig3. Diagram for Fresnel reflector

IMPROVEMENT:

The absorber design factors must be optimized. By reducing parasitic losses tracking options can be improved.

Ib (w/m2)	Tout (°C)	Overall
		Efficiency
300 w/m2	31.27°c	34.98%
400 w/m2	35.97°c	45.98%
500 w/m2	40.67°c	52.45%
600 w/m2	45.37°c	56.82%
700 w/m2	50°c	59.94%
800 w/m2	54.78°c	62.28%

Table2. Normal radiation vs efficiecy

3. DISH STIRLING-

Dish Stirling consist parabolic reflector that concentrates light onto a receiver at reflectors focal point. Working fluid in receiver is heated to 250-800 ° C and then it is used by stirling engine to generate power. This system provides efficiency upto 31-34 %.The point focusing . There is no water requirement. The heat storage is difficult. It uses Dual axis tracking system. [3]



Fig4. Diagram for Dish stirling

IMPROVEMENT:

The system efficiency could be improved by increasing the current .

Improvement in the fan and pump operating speeds in addition to the aperture

diameter would optimize the electrical earnings by several dollars in a huge Stirling dish field.

4. SCHEFFLER CONCENTRATOR-

Scheffler concentrators fixed focus concentrators used to medium temperature applications. This concentrators are design to maintain a fixed focus using single axis mechanism. It concentrates sunlight in two dimensions to a "point" or small area, allowing heat flow without a dedicated mechanism such as transfer fluid. The efficiency of this concentrators is depend on its size.



5.Schematic arrangement for Scheffler reflector

by balancing the two solar cells, we need to set at an angle to each other, when the cells were not pointed at the sun evenly, one cell would have the higher voltage, and power the motor. By research it is found that this arrangement did not provide enough power to properly move the reflector, and would put the motor under constant load from the two photovoltaic [5]

Maximum temperature	1020°C
reached at focal at focal	
point	
Maximum optical	
efficiency	84%
1.Reflector surface	75%
from clear glass	
2.Reflector surface	
from optical glass	
Average cooking power	2,2Kw
at 700 W/m ² insolation	1,7 kW in summer and
with normal glass	2,5kW in winter
mirror	
Maximum number of	3
pots per reflectors	
Cost of material for on	Approximately 500
reflector (in India)	Euro
Used materials	Steel profiles and
	glass mirrors

Table3. Date on 8m² 10m² Scheffler reflector

IMPROVEMENT:

The tracking system is single axis tracking. The rigidity of fiberglass is known by the no. of layers of fiberglass cloth and type of resin. This is used to control the mirror rigidity and reduce mirror warping. The initial results are good; the fiberglass is also strong, but is also fairly flexible. Continuing this work will develop new methods of molding the fiberglass for fast, accurate, and inexpensive manufacturing of the fiberglass mirrors.



Fig6. Modified tracking system circuit.

III. CONCLUSION:

SYSTEM	EFFICIENCY
Parabolic Trough	26-29%
Fresnel Reflector	30-60%
Dish Stirling	31-34%
Scheffler Reflector	Depends on size

From above comparison based on efficiency we can conclude that FRESNEL ARRANGEMENT is better for steam generation. As the scheffler reflector's efficiency depends on size but as size increases cost of the reflectors also increases.

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