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Overview of Solar Thermal Plant Technology

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Abstract

Energy, an indelible ingredient in the creation is all pervasive in its potentiality. Etymologically, energy is "the potential ability of a system to influence changes in other systems". Unfortunately, to satisfy this ever galloping energy needs of the modern day world, non renewable forms of energy were exploited and utilized without realising its consequences of hazardous effect on environment and health, early depletion; thereby probably leaving a little scope for their replenishment. This is the problem that has made the humanity look out for alternative forms of energy. Particularly, to be India centric when there is a growing pressure from the developed world to cut emissions and abide the "COPENHAGEN" and various other regulations framed at numerous "Climate Change" Summits, it is the need of the hour to look out for options in the field of alternative energies. Basically New and Renewable energies are classified into Wind, Solar, Hydro energies & energies form Biomass. As India slowly marches ahead with its vision to be the hub of Solar energy by utilizing it with peaceful, participatory & environment friendly methodologies it is of no doubt that Solar Energy is the energy of the future. The current work presents the result of such an analysis with the purpose of obtaining more insight into understanding the thermal behaviour and the economic viability of solar power plant for electricity generation.

1. Introduction

The tremendous amount of the total energy reaching the earth from the sun has attracted the attention of many engineers and scientists to consider it as a substitute for some of the present energy demand. The most popular solar energy conversion system is the low temperature thermal converter, of which flat plate solar collector is an example. However, this device is used normally only for small collection system of, at most, a few thousand square meter collector area. Above this limit it is not as yet viable economically and so for this purpose more appropriate system has to employ for large applications. The idea of solar thermal power plant presents an attractive way of collecting solar energy on a large scale to meet the energy demand for a variety of large scale applications, such as electric power generation and industrial process heat.

2. Basis of Selection

Electric power may be produced from solar energy in wide variety of ways. Attention was restricted in this study to solar energy system that meets following requisites:

A-power is generated via thermal conversion.

B-The power range is divided into two parts;

1-0.1to 10 MW for small scale solar power systems

2-greater than 10MW for large scale solar power system

C-The concept have the potential for commercialization in the 2000-2010 time frame. [1]

3. Selection of Thermal Working Fluid:

The choice of working fluid depends on the operating temperature and type of heat engine. Steam is the most widely used fluid in heat engine that operate in the MW range due to its low cost, high chemical stability, and a universal availability. But for smaller engines, due to some technical and other operation reasons, generally organic fluids are used as a working fluids and are selected based on their physical and thermodynamic properties.

4. Proposed Technology

Concentrating solar power (CSP) plants produce electricity by converting the infrared part of solar radiation into high temperature heat using various mirror/reflector and receiver configurations. The heat is then channelled through a conventional generator. The plants consist of two parts: one that collects solar energy and converts it to heat, commonly known as ‘solar field’ and another that converts heat energy to electricity, known as ‘power block’.CSP plants use the high-temperature heat from concentrating solar collectors to drive conventional types of engines turbines.

5. Overview of concentrating solar power technology

All CSP are based on four basic essential sub systems namely collector, receiver (absorber), transport/ storage and power conversion. Following four CSP technologies have either reached commercialisation stage or are near it:

Parabolic Trough
Power towers
Parabolic Dishes (Dish-Sterling)
Compound Linear Fresnel Reflectors (CLFR)

Table 1: Technological maturity level of CST technologies [2]

CSP Technology Type	Installed Capacity (MW) till 2009	Appropriate capacity under construction and proposed (MW)
Parabolic Trough	500	> 10,000
Central Receiver	40	> 3,000
Parabolic Dish-Sterling	< 1	> 1500
CLFR	5	> 500

Table 2: Technical Characteristics of CSP technologies [2]

CSP Technology	Concentration Ratio	Tracking	Solar Radiation	Thermal Input	Thermal Storage	Area Required* (acre/MW)	Total Installed Capacity	Projects	Company
Parabolic trough	80	Single axis	Direct radiation over single axis	250-400 oC	Possible	7-8	> 400 MW	SEGS, USA (354 MW) ANDASOL-1 (50 MW)	Luz International Ltd. Solar Millenium

Central receiver	500-1500	Two-axis	Direct Normal Incidence	250-1200 oC	Possible	14-15	>25 MW	PS-10 (11 MW) Solar Tres (17 MW)	Abengoa Solar SENER, Sppain
Parabolic dishengine	500-1500	Two-axis	Direct Normal Incidence	700 oC	Not Possible	7-8	< 1MW	NA	Sterlingen gine systems
Concentrating Linear Fresnel Reflectors	80	Single axis	Direct radiation over single axis	250-400 oC	Possible	4-5	1 MW	NA	Ausra Australia

6. Steam Accumulator

The most appropriate means of providing clean dry steam instantaneously, to meet a peak demand is to use a method of storing steam so that it can be 'released' when required. Storing steam as a gas under pressure is not practical due to the enormous storage volume required at normal boiler pressure. [3]

7. Limitation

There are several limitations in the effective conversion of solar energy into electric power. Some of them are:-

1. The main problem is that the efficiency of the collection system decreases as the collection (operating) temperature increases while the efficiency of the engine increase as the working fluid temperature increases.
2. The theoretical efficiency that can be obtained by any heat engine operating between two temperatures is well understood and provides fixed fundamental barriers.
3. A part of heat is lost from the working fluid during its passage from the collector.
4. Due to the intermittent nature of the solar energy some kind of energy storage device is required to operate the heat engine continuously. The heat storage material degrades with time. [5]

8. Conclusion

With the increase in population, the demand of electricity will also increase and by the use of conventional resources it will be difficult to cope with the increase in demand. For that we have to go for renewable energy resources mainly solar thermal with it advanced technologies. The solar thermal technology is in initial phase in India but in coming year it will play major role in the development of energy sector in India. The pilot project of solar thermal technology of 1 MW is operational in Amritsar. The initial cost is more in solar thermal technology but operational cost is very low as compare to other technology.

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