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Solar Thermal Technology for Use in Developing Countries

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Abstract

Solar thermal is an alternative energy conversion process like photovoltaic system. There is a wide application of solar thermal energy in our domestic life and industrial arena. In this paper some notable examples of solar thermal applications have been discussed. This paper also refereed the application of solar thermal in different developing countries.

Introduction

Although the ideas of conservation are probably as old as human species, the use of the word in its present context is relatively recent. Conservation of energy involves practices that perpetuate the resources of the earth on which human beings depend. Energy extraction, collection, distribution and utilization: all these stages of energy technology are equally important for maximizing our energy resource capacity. Nevertheless, efficient collection of solar energy calls for special attention since there is a room for drastic improvisation in this field. This is even more important in the perspective of the developing countries, where there are an urgent and immediate need for generating a huge amount of electricity and thermal energy. Many attempts have been made to use solar energy to operate power plants to heat water, cook food, distill water, industrial process heating and cooking and so on. Other potential applications that may be mentioned are drying of agricultural products, steam generation, timber seasoning, purification of drinking water etc. A practical use of solar energy depends on the collection of insulation and conversion into thermal energy since thermal energy is the intermediate stage of any other energy conversion stage. Once enough thermal energy is collected, other useful higher-grade energy (i.e., electricity) becomes attainable at good efficiency.

Different Applications of Solar Thermal Energy

Solar thermal energy has some promising applications in our day-to-day life especially in rural areas. Tremendous opportunities are there in the field of solar thermal arena. New schemes are evolving both in developing and developed countries. Production of electricity by solar thermal technology is a very lucrative agenda now in Western USA. In Europe, solar greenhouse projects are improving time to time. Most important fields of solar thermal applications are sketched below:

Water heater: Heating of water using solar energy has the commercial application, which is economically viable. In tropical countries solar water heaters find wide application in large establishments like hospitals, hostels and industries. Different types of solar water heaters have known considerable developments in different countries like Greece [Karagiorgas et. al. (2000)]. Cyprus [Kalgiri (1997)] (it is repeated that there is one solar heater for every 5 people in the island), India, South Africa [Mathews (2000)]. Switzerland etc.

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Two types of solar hot water system are fabricated in Bangladesh (Taskina 1996)] each of 400 litres of capacity per day at the temperature range (55-60) degree celcius.

Applications: Water heater for domestic use, Hotels, Hospitals, and Industrial process etc.

Air heater: Solar air heating systems use air to transport from warm spaces (directly or indirectly) to heat ventilation air, or heat domestic hot water. Alamdari studied the performance of two pass flat plate solar air heater in which air flowing simultaneously over & under the absorbing plate by using of laminar flow assumption for flowing air [Alamdari (2000)]. For a given air mass, it is found that the useful heat gain by air and performance of two-pass solar air heater is greater than one-pass solar air heater. The multi-pass airflow in the solar air heater gives higher efficiency.

Applications: Space heating.

Solar cooker: The major portion of energy consumption in developing countries is for cooking in domestic sector. 62% of world population rely on firewood for cooking, which is becoming scarce. Solar cooking seems to be a feasible proposition. According to Nahar [Nahar (2000)], the improved non-tracking solar cooker has been found best among solar oven, hot box cooker etc. The efficiency of this cooker is 28.9% and save about 1400MJ of energy per year.

Applications: Steam production and distillation. Hot water production, cooking etc.

Solar dryer: Natural solar drying of food remains the main drying method for most of the rural people in developing countries. But it has many disadvantages. Large amounts of agricultural products are lost in most of the developing countries. But it has many disadvantages. Large amounts of agricultural products are lost in most of the developing countries. New technologies should always be introduced to save food for the increasing world population. It is hoped that the solar drying will be an important method of food preservation for the coming 21 century.

Applications: Wood Seasoning, Solar Tunnel Dryer, Tobacco Curing, Fish drying etc.

Refrigeration and cooling system: Conventional energy scarcity in some regions, environmental concerns and the favorable solar radiation cycle support solar refrigeration. A new solar powered air conditioning system has been developed where water is used as the refrigerant instead of CFC, is an environmentally sound system [Wolpert (2000)].

Adsorption cycles can be used in heat driven refrigerators, air conditioners or heat pumps in which the energy source is a burning fuel or waste heat. Examples include the use of waste heat to provide cooling, heat pumping, industrial refrigeration, vehicle air-conditioning and the refrigeration of food in parts of the developing world where there is no electricity supply to power conventional vapor compression. Critoph's [Critoph (2000)] work established a solar power adsorption refrigeration system. Solar Powered vapor compression, LiBr-H₂O, H₂O-NH₃, AC-Methanol and CaCl₂-NH₃ systems have potentials for early entry into the market. Their high cost and low overall Cycle or Solar Coefficient of Performance (COP) (0.10-0.45) requires significant improvements to compete favorably with grid powered vapor compression units with overall COP of about 1.0.

Applications: Solar Air Cooling is used in Cold Storage and Cooled in House. Solar Refrigeration is used to preserve meat, fish, fruits, Vegetables, Food etc for a long time.

Solar electricity generation: Solar thermal technology using concentrating systems is applicable for solar electricity and/or for process heat generation. Both applications may use similar concentrating collector systems (dish, tower and trough systems), but of different engineering approach and specifications. They are applicable for central and distributed electricity generation. For the generation of bulk electricity, after wind facilities, solar thermal power plants possess the highest potential for competing with conventional power plants. While the solar electricity generation by solar thermal technology was the favorite starting base for the R&D efforts, resulting in first commercial success of nine parabolic trough power plants with 354 MW energy of total installed plant capacity in the South-Western USA energy market of California, the large solar process heat potential is yet nearly unexplored [Becker et. al. (2000)].

Applications: Different types of Solar Concentrators are used to generate electricity.

Solar green houses: The solar greenhouses are intended to provide the much-needed heat to facilitate the healthy growth of agricultural plants especially during the cold period. The greenhouses in Western Europe should be designed to collect as much solar energy as possible, In these constructions, solar radiation is used for heating as well as for photo-biomass conversion via the photosynthesis process [Granqvist et. al. (1998)]¹. Under certain circumstances, however, optimal plant production requires the greenhouse to be cooled. Pollet et. al. (2000) designed an effective low cost system which should enable to lower the inside air temperature of an earth tube heat exchanger system for greenhouses.

Solar Gur Production: Date Palm Juice are produced by Different types of Solar Concentrators like Fresnel Reflecting concentrator, Paraboloidal Concentrator, Cylindrical Paraboloidal Parabolic Trough, Compound Parabolic Collector(CPC) etc. In the southern region of Bangladesh this solar system will prevent the cutting of Forests.

Solar Paddy boiling: At 80 degree celcius temperature Paddy has been boiled and is possible with any type of Solar concentrator like Fresnel Reflecting concentrator, Paraboloidal Concentrator, Cylindrical Paraboloidal Parabolic Trough, Compound Parabolic Collector(CPC) etc under the Climatic condition of Bangladesh.

Solar Tobacco Curing: To keep the humidity, the process of tobacco curing has been divided in to three parts. The process such as:

- (a) Virginia Tobacco: In this process Tobacco is cured by Hot Gas flow.
- (b) Barly and Meriland Tobacco: In this process Tobacco is cured by Hot Air.
- (c) Terkis: In this process Tobacco is cured by Solar Radiation.

Solar Candle Production: The working principle of Solar system for Candle Production is very simple. Any Person with little training can do this job. The Solar system needs no extra space and can be operated in the house, terrace, courtyard, field or any open space where Solar radiation are easily available. The solar system is quite simple and successful for convenient candle Production. This system is likely to generate the employment among the

needy people of Bangladesh. Any Bangladeshi Business Company can take-up this technology for its commercialization all over Bangladesh.

Solar Soap Production: Soap comprises the sodium or potassium salts of various fatty acids such as Oleic, Stearic, Palmitic, Lauric and myristic acids. For generation its use has increased until its manufacture has become an industry essential to the comfort and health of civilized human beings. Sodium salts are called hard soaps and Potassium salts are called soft soaps. The soaps are soluble in water and the solution has excellent lathering and clearing properties. The basic principle of making all kinds of soap such as toilet, laundry, household, medicinal, marine and industrial soap is the same. The combination of higher fatty acids with sodium or potassium hydroxide or carbonate. Shaving cream soap are well known examples of soft soaps, while other types given above are examples of hard soap. Soap is either made by hot process or cold process. Usually laundry soap or bath or toilet soaps are manufactured by hot process. Transport and other special types of soap are made by Cold process. In our solar system soap obtained from the hot process by any type of Solar Concentrators like Fresnel Reflecting concentrator, Paraboloidal Concentrator, Cylindrical Paraboloidal Parabolic Trough, Compound Parabolic Collector(CPC) etc.

Solar steam Production & Distillation: Solar thermal steam production and distillation of water by making good use of the solar system may be made by very useful and purposeful in the context of energy consumption pattern of the rural areas of Bangladesh where the conventional energy sources are scarce and merge. These distillation device can serve many purposes in rural health centres and can be utilized as a desalination device in coastal areas. The steam produced at the atmospheric pressure can be utilized in sterilizing the bandages materials and operation tools of the rural health centres where conventional steam plant is not available.

Other uses: Solar poultry chicken brooder [Sheyin (2000)], solar egg incubators and hatching machines are not yet finding widespread utilization in poultry production. These depend on solar thermal. There are a lot more applications on solar thermal but most of these scopes are beyond the reach of the poor people.

Conclusion

Solar energy is an important and environmentally compatible source of renewable energy. Presently, many research and development programmes in developing countries are oriented towards the effective utilization of solar energy technologies, Moreover, current interest and activities in the field of solar thermal for various applications are also expanding rapidly. And in every case, supports from different corners are prerequisite for the rapid improvement of solar thermal application in developing countries.

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