Available online at www.sciencedirect.com

ScienceDirect

Procedia Computer Science 111 (2017) 427–434

Procedia Computer Science

www.elsevier.com/locate/procedia

8th International Conference on Advances in Information Technology, IAIT2016, 19-22 December 2016, Macau, China

Trigeneration Solar Thermal System

S.K Deb[a] and B.C. Sarma[b*]

[a]*Professor, Department of Mechanical Engineering, Assam Engineering College, Guwqahati,India,email:sudipkumardeb@Gmail.com*
[b]*Research Scholar, Department of Mechanical Engineering, Assam Engineering College, India, email:bcsbinoy@Gmail.com*

Abstract

Use of both the optical & conductive properties of a metallic plate solar concentrator enhances the recovery of absorbed waste heat to improve the net system performance. In this investiagation, a solar thermal system has been proposed which will facilitate the process heat for industrial purposes in a wide range of low to medium temperature. An analytical study followed by an experimental study of a bench model of trigeneration solar thermal system is conducted in this investigation. The drying & heating application in the low to medium temperature range using the recovered heat with the enhancement by the normal irradiative heat concentrated at the focus of the concentrator is envisaged to be accelerated through increased mass flow rate with energy storage to meet up a sustainability support.

Peer-review under responsibility of the organizing committee of the 8th International Conference on Advances in Information Technology

Keywords: Trigeneration, Convective, Desalination, Aperture, Process heating, Insulation;

1. Introduction

Trigeneration is concerned with the triple energy outputs with different thermal qualities impling a system preferably in a decentralized mode of energy source generating steam of different qualities like wet, dry & superheated steam, hot water, hot air & absorption cooling system simultaneously at a time. If the heating source is the solar irradiation, the system acts as trigeneration solar thermal system (TST). Conventionally, as a trigeneration system, a photovoltaic thermal (PVT) system integrates solar photovoltaic cell and solar thermal systems for the co-generation of electrical and thermal power from solar energy**.** Available method on choices are of mono crystalline/

* Corresponding author. Tel.: +91-0361-7896805927;
E-mail address: bcsbinoy@gmail.com

1877-0509
Peer-review under responsibility of the organizing committee of the 8th International Conference on Advances in Information Technology
10.1016/j.procs.2017.06.044

polycrystalline/amorphous silicon (c-Si/pc-Si/a-Si) or thin-film solar cells, flat plate or concentrator types, air/liquid/evaporative collectors, glazed/unglazed designs, natural/forced fluid flow, and stand-alone/building-integrated features. The PVT systems may be PVT air, PVT water heating system through PV-integrated heat pump or pipe or combined heating & cooling and actively cooled PV concentrator through the use of lens or reflectors. Engineering considerations can be on the selection of heat removal fluid, the collector type, the energy balance of the system, the thermal to electrical yield ratio, the solar fraction etc having the determining effects on the system operating mode, working temperature, and energy performance. Unglazed or glazed (double or single cover) polygeneration as referred at Figure. 1 , the PVT collector is the application of the polygeneration approach on the normal PVT system exposed directly to the sunshine whereas polygeneration PTCPVT (Parabolic Trough Concentrator PVT) Collector as referred at Figure. 2 is one of the improvisations for intensifying solar irradiance on the cell at it's line focus to generate more electricity simultaneously with the extraction of heat, bringing the PV temperature to an optimal range.

There are several investigative information in literature in the field of co-generation, trigeneration or polygeneration solar system. Solar thermal polygeneration (STP) system developed by Gowtham Mohan et el.[1] for production of chilled water for air conditioning using absorption chiller, pure water with membrane distiller and domestic hot water by heat recovery showed the advantages of combined operation through effective utilization of heat lost in the process operation. Transient simulations of a solar trigeneration model designed by Calise et al. [2] integrated together with PVT collector for combined production of vapor absorption chiller cooling, desalination and power was performed with an optimized energy efficiency and economic viability output. Investigation by Liu [3] et. al. on trigeneration for membrane distillation with heat recovery chiller for cooling, power and water for chip manufacturing unit, works of Hussain at.el. [4] on hybrid polygeneration systems in Kuwait for production of power, fresh water and cooling simultaneously, CPVT works at Yunnan Normal University [5–8] for simultaneous production of electricity & heat, a CPVT system based on a dome-shaped linear Fresnel lens combined with a CPC secondary concentrator for façade building integration purposes by Chemisana et al. [9] etc are a few of such polygeneration or trigeneration energy system under investigation. Even as on low concentration CPVT, the investigation of Proell et al. [10] at the Bavarian Center for Applied Energy Research, Germany & of Liao et al. [11] may be recalled alike our proposed TST system. Works of Ulavi et al. [12], Hedayatizadeh et al. [13], Zhang et. al.[14] & Ong et al. [15] for CPVT based water desalination with electricity have enough contribution in this field although it involves power generation as one of it's outputs.

Fig. 1. Unglazed Polygeneration PVT collector

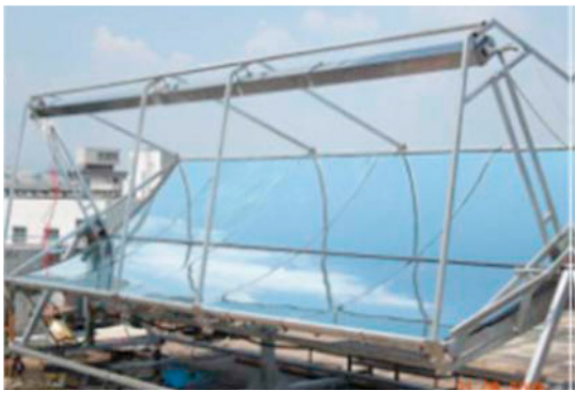

Fig. 2. Polygeneration TCPVT collector

2. Proposed TST System (Bench Model)

As referred to the Figure. 3 the bench model of the proposed system is comprised of a stainless steel sheet reflecting surface of 75% of reflectivity & of 3.2 kg mass formed into a parabolic trough concentrator of 0.57 m^2 surface area embedded with the water pipes at it's rear surface with two glass covers at it's aperture. The radius of curvature is so deigned to maintain the focal line at the aperture plane to ease the structural placement of the receiver. The entire system is well insulated at the rear surface & also to minimise the end losses.