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Measurement of Solar Thermal System Possibility for Industrial Process Heating Applications

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ABSTRACT

Current research on industrial heat demand shows that more than 50% of the industrial heat industry should be in the low (<60°C), medium (60-150°C) and medium-high (<250°C) ranges.) gold. A large part of the world economy relies partially or entirely on a combination of carbon-based fossil fuels to produce heat. Commercial solar thermal technology has the potential to form a significant part of the low-temperature process that will reduce fossil fuel use and impact the cost of energy conversion and carbon emissions. In addition, the development and popularization of solar energy products in recent years and the beginning of the use of solar energy have made solar thermal systems a business competition with long-term business and inflation returns. Despite these advantages, it is surprising that solar thermal systems are used for heating systems.

The biggest problem in installing solar thermal systems for heating systems involves a poor understanding of the performance of solar thermal systems in different conditions. There are no robust and cost-effective design decision support tools to evaluate heat loads and insolation values and the quality of individual projects. The research presented in this article aims to help reduce the impact on the commercial export of solar thermal energy by: 1) elucidating the efficiency of solar solar panel thermal systems with gas recovery (solar/gas hybrid heating system) from experimental research, mainly due to the differences between electric and solar energy systems. Based on the difference, predict the heating process of different industrial processes. temperature and natural gas prices, 3) identifying hybrid solar/gas heating system configurations that provide greater system efficiency when combining solar and gas heating modes, and 4) developing and demonstrating design decisions for solar thermal system feasibility assessments Support tools. The results of this study will allow experts and decision makers in the industry to conduct situation analysis to evaluate the feasibility of solar thermal system application, reducing the cost and needs to be used according to the specific information in the space. Possible

1. Introduction

Power

Businesses are the largest consumer of energy, accounting for approximately 43% of all energy consumption worldwide [1]. A large part of the world's industrial economy relies partially or entirely on the combination of carbon-based fossil fuels to produce heat [2]. Fossil fuels are finite and non-renewable, and their destruction is identified as a problem in the future [3]. In addition, burning fossil fuels causes serious environmental problems such as air pollution, global warming and acid rain. In comparison, renewable energy does not run out and produces very few emissions due to global warming [4]. Renewable energy systems therefore offer the opportunity to reduce fuel consumption and carbon emissions.

Solar technology for commercial heating needs has been the subject of study and business research for decades. Commercial solar thermal technology can easily form a significant part of the low temperature process [5], which will reduce fossil fuel consumption and impact the cost of energy conversion and carbon emissions. With the development and popularization of solar technology and the introduction of solar energy in recent years, solar thermal system has become a common business competing with long-term, inflationary returns [6]. Besides energy savings, job creation is another important economic benefit provided by solar thermal systems – approximately 828,000 jobs were created worldwide in the design, installation and maintenance of solar thermal in 2016 [7]. < br >Despite the huge benefits, the actual use of solar thermal systems for heating systems is surprising. As of the end of 2016, the world's solar thermal capacity was only 456GWth. Among them, the process heat industry accounts for only 3% of the total equipment capacity [8]. Therefore, more studies are needed to identify and solve the problems that prevent the widespread use of solar thermal technology in the heating process.

2. Book Review

The solar thermal system is a simple and cost-effective renewable energy system that uses solar energy for heating. Solar thermal systems generally consist of solar collectors, generators, generators and generators. Solar collectors capture the incoming solar radiation and send it to the working water flowing in the pipeline. The energy carried by the working fluid is used directly or used to charge the thermal energy storage tank. Due to seasonal changes in sunlight and solar energy, auxiliary power with solar collectors is used to restore heat when sunlight is not sufficient.

Flat plate collector (FPC) is the most common type of solar device suitable for collecting solar energy from low temperature water (30 to 80 °C) [26]. As shown in Figure 2.1, the FPC consists of: a metal box with a clear glass or plastic cover (glass) on top to reduce heat, a dark absorber on the bottom and tubes containing heat transfer. water [27]. The bottom of the absorber and the sides of the metal box are well insulated to reduce heat loss [27].

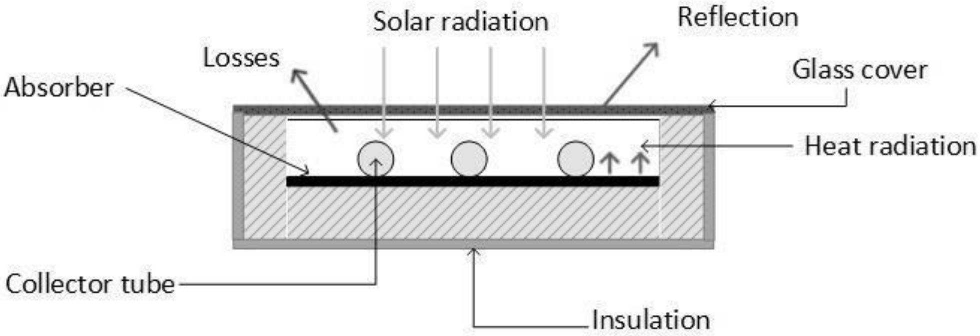


Figure 2.1: Sketch of a solar flat-plate collector

Collector glazing is made up of glass or other similar radiation-transmitting materials because of their high transmissivity of short-wave radiation and low transmissivity of long-wave radiation [27]. Glass with low-iron content has been widely used as the glazing material [27] because of its high transmittance of solar radiation (approximately 0.82-0.87 at normal incidence [28]) and an essentially zero transmittance for long-wave thermal radiation (5.0 μm – 50 μm). The collector absorber plate is the heart of the

FPC. It absorbs the maximum possible radiation incident through the glazing [27]. The thermal performance of an absorber plate depends on its material properties and design parameters [29].

As reported by Duffie and Beckman [26], for steady state operating conditions, the rate of useful energy collected by a solar FPC can be calculated using the Hottel-Whillier- Bliss equation as (Eq. 2.1):

$quseful = FRAC[IT(r\alpha) - UL(Ti - Ta)]+$ (2.1)

where FR is the collector heat removal factor, AC is the collector aperture area value, IT is the average daily solar radiation, UL is the collector overall heat loss coefficient, Ti is the collector fluid inlet temperature, Ta is the ambient temperature, and $r\alpha$ is the product of collector transmittance and absorptance.

The collector efficiency (η) is the ratio of the useful thermal energy delivered by the collector to the usable solar irradiance falling on the collector's aperture area and is expressed as [30] (Eq. 2.2):

$(Ti - Ta)$ $(Ti - Ta)2$

$\eta = \eta o - k1\ I - k2\ I$ (2.2)

where ηo is the efficiency when $Ti = Ta$, and $k1$ and $k1$ are the collector heat loss coefficient values.

Chapter 3. In studies on the electrical overall performance of solar/fuel hybrid hot water systems, such as in the Pacific Northwest, solar equipment will not be cheap to meet the needs of year-round hot water demand, which requires ancillary equipment such as water heaters. Previous studies have shown that the efficiency of a water heater depends on the logarithmic temperature difference between the cold fluid (water) and the hot fluid (combustion gas). In a solar/oil hybrid water heater where the solar collector is used together with an oil heater, the part of water heating provided by solar energy input will reduce the logarithmic average temperature difference between the oil heater, thus the efficiency of the boiler will decrease. This. heater. Gas burner. Since this reduction depends on preheating from the solar input, it is difficult to estimate the exact cost and energy savings of a solar/gas hybrid water heater. Therefore, a better understanding of the performance of hybrid solar/oil systems is needed to estimate actual energy and cost savings based on various designs.

The purpose of this project is to determine the thermal performance of a hybrid solar/carbonated water system for hot water in Corvallis, Oregon, equipped with a 6.44 m2 flat panel solar array and a 22.3 kW natural gas burner. At different temperature increases and solar values, the system operates in three different heating modes: solar, gas and combined solar/gas mode. Calculate the total system thermal efficiency value for each mode. The efficiency of the heating equipment is 41.97%, 39.82% and 35.05% of the initial water temperature of 20, 30 and 51.5 °C, respectively.

Hot water accounts for approximately 18% of all electricity consumption in the United States [47]. Historically and currently, the US water heater market has been dominated by traditional gas-powered units, passive water pumps, and tankless water pumps [48]. A breakdown of domestic hot water use in the United States shows that approximately 48% of homes use natural gas, while 45% use electricity to heat water [49]. With growing concerns about carbon emissions and other environmental impacts associated with the extraction and use of fossil fuels, there has been interest in developing renewable energy sources for domestic hot water.

Solar Hot Water Systems (SWHS) are simple and low cost. Efficient technology to produce hot water using solar energy. The main components of SWHS are solar panels, hot water storage tanks and control systems. The working principle is that the solar collector absorbs incident solar radiation and transfers the energy to the working fluid (water or solar water) flowing in the pipeline. Working hot water can be used directly as hot water, or it can be charged to the thermal energy tank and energy can be drawn from the thermal energy storage tank for later use. Flat plate collectors (FPC) are the most common solar devices used to collect solar energy from low-temperature water [26] and are used commercially worldwide. It consists of a flat absorber covered with a transparent glass or plastic cover (glass) to reduce heat coming from the surface, pipes to transfer water to the body, and standard thermal insulation layers to reduce heat. from the surface. side and bottom of vacuum plate [26]

Percentage Solar energy fraction for a particular region, It often changes with the solar radiation problem [30]. Due to solar energy and seasonal changes in solar energy, heating equipment often needs to supply heat back when sunlight cannot meet the energy demand [26]. Resistive heaters are the most common type of electric heaters. Over the years, many studies have been conducted to evaluate the thermal performance of FPC solar water heating systems in steady-state and quasi-dynamic tests according to EN 12975 standard 2 [32] and ASHRAE 93-2003 [31]. For example, Rojas et al. [34] Anderson et al. [33] examined the thermal performance of steady-state FPC according to ASHRAE standards, while Zambolin and Del Col [35] and Rodriguez-

Results and Discussion

Solar heating mode only

The efficiency of the solar heating system was measured at three tank temperatures of 20, 30 and 51.5 °C. The final temperature was 60°C in all cases. Three scenarios were designed to simulate full tank evacuation and reheating ($\Delta T = 40°C$), return from the main pump ($\Delta T = 30°C$), and return from minor pumps or low pressure ($\Delta T = 30$ °C). The system is working. T = 8.5°C). Details of solar measurements are shown in Table 3.2. Using the reported uncertainty above, the maximum uncertainty in the calculation is ±0.09%.

Table 3.2: Summary of solar tests

Initial Tank Temperature (±0.2 °C)	Range of Incident Solar Flux (± 10 W m^{-2})	Number of Experiments Run	Range of Time to Heat Tank (hrs.)	Range of Overall Efficiency (%)
20.0	780 to 860	4	5.07 to 6.45	41.8 to 43.2
30.0	916 to 935	4	3.72 to 4.53	38.9 to 40.5
51.5	862 to 926	4	1.15 to 2.45	34.9 to 35.2

Figure 3.2 shows a summer day (22.08.2017) with the tank temperature starting at 20°C. Data is presented as a 25-minute moving average. In this experiment, it took 6.32 hours to heat the water tank to the desired temperature of 60°C. The average solar radiation measured during the experiment was 780 W m-2. Depending on the solar energy used and the temperature of the glycol water, the mass of the solar fluid varies from 42.5 to 63.7 g s-1, with an average air flow of 58.7 g s-1. The average temperature difference between the glycol-water mixture at the inlet and outlet of the solar coil tank is 10.15 °C. 3.2) It is 41.83%. Average performance is defined as the sum of all current (10-second) results divided by all data points during the solar wind warm-up.

During the first few minutes of the test, the cycle pump sends the glycol-water mixture pre-heated to the temperature in the cycle into the storage tank. This leads to a larger than expected solar water temperature difference (delta t, Tfo - Tfi) in the first few minutes of the experiment and the difference at the beginning of the activity well in Figure 3.2. When the fixed glycol-water mixture is completely circulated, the solar water temperature difference will be constant and represent instantaneous solar irradiance. 3.2. The efficiency of instantaneous heating equipment largely depends on the difference between solar water temperature and solar irradiance. The power curve of solar radiation on the operation of electrical equipment is shown in figure 3.2. It is seen that as the cost of solar energy decreases, energy consumption also decreases.

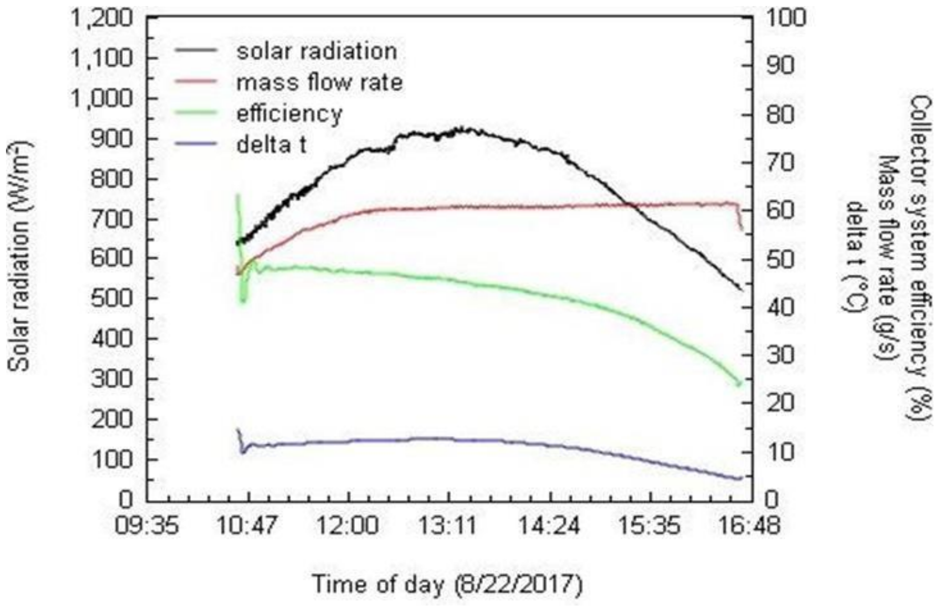
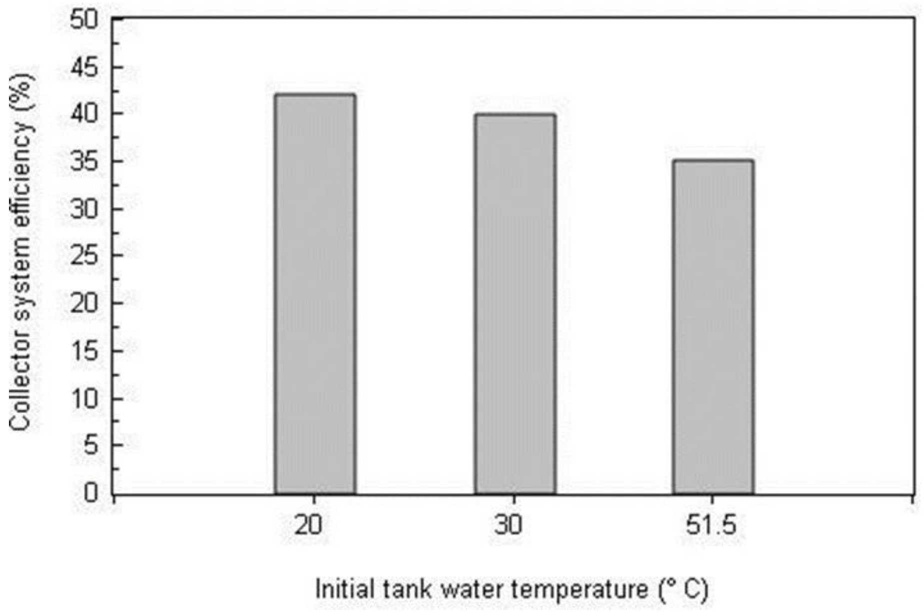


Figure 3.2: Collected sensor data and calculated efficiency values for a typical summer day (25-minute rolling average)



4. Research on Research and Marketing of Solar Thermal Energy for Small and Medium Businesses

Manufacturing requires a heating process for many industrial processes such as drying, cooking, washing, sterilization and pasteurization. Studies on electricity usage show that more than 50% of heating equipment requires low (<60°C), medium (60-150°C) and medium-high (<250°C). hot. If a significant portion of this low-temperature electricity can be produced by commercial solar panels, it will reduce fossil fuel use, electricity use and carbon emissions. However, the commercial sector cannot benefit from solar thermal for two main reasons: first, there is not enough information about when and what type of technology can be used to make money; Second, business transactions are often inappropriate. personnel or analysis Tools to determine solar thermal installation. The aim of this study is to help small and medium-sized businesses identify the use of solar panels for thermal energy in their businesses by developing decision support tools. In this study, the $\bar{\phi}, f$ graphic method was used to estimate energy harvest from solar thermal systems and the developed $\bar{\phi}, f$ graphic model was used. A simple design model was prepared to evaluate the economic potential of the solar panel power source. To illustrate the approach, the decision support software model is implemented with a number of negative assumptions. Sensitivity analysis of the savings-investment ratio (SIR) is performed by varying the input options by ±30% relative to the baseline data. It has been shown that the most important factor in electricity cost is the SIR rate, followed by electricity cost, discount rate, preheating system cost and heating oil cost.

Flat plate collector (FPC) is the most common type of solar energy device suitable for collecting solar energy in the temperature range of 30 to 80 °C [30] and is the focus of this study. It is an inexpensive option that can be used in many applications that require low thermal energy, such as space heating and process heating [57]. Information on other types of collections is available from various sources [27,77].

Table 4.1: Types of solar energy collectors [27]

Sun-tracking configuration	Collector type	Absorber type	Concentration ratio	Indicative temperature range (°C)
Non-tracking (Stationary)	Flat-plate collector (FPC)	Flat	1	30-80
	Evacuated tube collector (ETC)	Flat	1	50-200
	Compound parabolic collector (CPC)	Tubular	1-5	60-240
			5-15	60-300
Single-axis tracking	Linear Fresnel reflector (LFR)	Tubular	10-40	60-250
	Parabolic trough collector (PTC)	Tubular	15-45	60-300
	Cylindrical trough collector (CTC)	Tubular	10-50	60-300
Two-axis tracking	Parabolic dish reflector (PDR)	Point	100-1000	100-500
	Heliostat field collector (HFC)	Point	100-1500	150-2000

5.Conclusions

Advances in equipment technology in recent years have made solar thermal systems a viable option for low-temperature processes. However, US production of solar technology is relatively low. Business owners will be willing to invest in solar technology if they see clear economic benefits after conducting specific research on the site. However, the cost and resources required to identify the potential of solar thermal and conduct research are not satisfactory for business owners. There is currently no readily available, cost-effective decision support tool that business analysts can use to evaluate the quality of solar thermal. The aim of this research is to reduce the problems associated with the use of solar energy in the use of heating systems. The following tasks were carried out within the scope of this study.

Project 1: A series of experiments designed for a solar/oil hybrid domestic hot water system were carried out at different heating modes, temperature increases and solar values. Using the data collected, the following performance indicators were calculated: solar collector efficiency, gas heating efficiency and combined solar/gas system efficiency. The results of the study were used to determine configuration methods that would lead to better performance when operating the hybrid system in hybrid solar/oil heating mode.

Task 2: Develop a decision support tool to help business analysts evaluate the feasibility of the solar panel energy products designed and produced in this study for the heating process. A cost model is developed and presented to support business analysis. A sensitivity analysis is presented to identify the uncertainty associated with the inputs. The use of decision support tools and analysis of various hypotheses are demonstrated through the use of models.

References

[1] J. Veerapen, M. Beerepoot, Combined heat and power and renewable energy, IEA Paris. (2011).

[2] P. Mekhilef, R. Saidur, A. Safari, Examination of the use of solar energy in industry, Renewable resources. overcome healing power 15 (2011) 1777–1790.

[3] M. Höök, X. Tang, Fossil fuel consumption and human-induced climate change - kev tshuaj xyuas, Energy Policy. 52 (2013) 797–809.

[4] O. Edenhofer, R. Pichs-Morning , Y. Sokona , K. Seyboth , P. Matschos , S. Kadner , T.S. Zwickel, P. Eickemeier, G. Hansen, S. Schlömer, IPCC Special Report on Energy Efficiency and Climate Change, Preparation. Work. The third group is collaboration. The panel increases. He's Back. University. Press Cam. England (2011) 49 (2015).

[6] P. Lorenz, D. Pinner, T. Seitz, The Economics of Solar Energy, McKinsey Q. 4. (2008) 66–74.

[7] Renewable Energy and Jobs – 2017 Annual Review, International Renewable Energy Agency, 2017. http:// www.irena.org/documentdownloads/publications/irena_re_jobs_annual_r eview_2017.pdf.

[8] W. Weiss, M. Spörk-Dür, F. Mauthner, Global Market Development and Market 2016, IEA Solar Heating and Cooling Programme, 2017.

[9] J.H. Davidson, Low-temperature solar thermal systems: America's untapped energy resource, J. Sol. Energy Engineering. 127 (2005) 305–306.

[10] S. Kalogirou, Potential of commercial solar heating process, Appl. importance. 76 (2003) 337–361. [11] H. Schweiger, J.F. Mendes, N. Benz, K. Hennecke, G. Prieto, M. Cusí, H. Gonçalves, Solar energy potential in industry. For a review of new technologies in Spain and Portugal see: EuroSun, 2000.

[12] K. Henecke, Solar process heating for production and advanced applications, IEA SHC Task, 49 (2015).