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CURRENT ABSTRACTS

Solar Thermal Energy Technology

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ABOUT THIS PUBLICATION

Solar Thermal Energy Technology (STT) announces on a bimonthly basis the current worldwide research and development information that would expand the technology base required for the advancement of solar thermal systems as a significant energy source. This publication contains the abstracts of DOE reports, journal articles, conference papers, patents, theses, and monographs added to the Energy Science and Technology Database during the past two months. Also included are U.S. information obtained through acquisition programs or interagency agreements and international information obtained through the International Energy Agency's Energy Technology Data Exchange or government-to-government agreements. The digests in *STT* and other citations to information on solar thermal energy dating from 1974 are available for online searching and retrieval on the Energy Science and Technology Database. Current information, added daily to the Energy Science and Technology Database, is available to DOE and its contractors through the DOE Integrated Technical Information System. Customized profiles can be developed to provide current information to meet each user's needs.

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Sponsor → Sponsored by USDOE, Washington, DC (United States). DOE Contract BC23-123456789. Order
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Solar Thermal Energy Technology

SOLAR THERMAL POWER SYSTEMS

152
(CONF-931269–, pp. 89-92)
Conceptual consideration on PV systems for advanced regional energy-supplying activity 'PV-AREA'. Kurokawa, K. (Electrochemical Laboratory, Tsukuba (Japan)). Japan Solar Energy Society, Tokyo (Japan). 9 Dec 1993. 323p. (In Japanese). From 1993 JSES/JWEA Joint Conference and '93 Japan-Korea Joint Conference on Solar Energy; Tsukuba (Japan); 9-10 Dec 1993. In *1993 JSES(Japan Solar Energy Society)JWEA(Japan Wind Energy Association) Joint Conference and '93 Japan-Korea Joint Conference on Solar Energy(December9and10,1993).* Order Number DE94767725. Source: OSTI; NTIS; Available from Japan Solar Energy Society, Sun Patio 322, 1-5, Takatanobaba 3-chome, Shinjuku-ku, Tokyo, Japan.

This paper presents a conception of the regional energy supplying system (PV-AREA) as a utilization form compatible with features in a discrete type photovoltaic power generation system. The photovoltaic power generation system is characterized by being an energy supply system closely connected with regional communities, and capable of location even in areas with no utility power system available. The PV-AREA is divided largely into a centralized arrangement and a discrete arrangement. The case of the centralized arrangement requires securing land for the arrays as a prerequisite. Specifically, desert areas blessed with insolation conditions in developing countries are assumed. Their potentiality is as large as they can take care of the world energy requirement. The most critical assignment for this case is the cost reduction in a total term. The discrete arrangement assumes existing towns and villages, suburban communities, and industrial complexes, of which total amount of power generation can grow as large as it can not be ignored. This case requires discussions on levelling of load profiles and power generation profiles in relation with the community services. 3 refs., 5 figs., 1 tab.

153
(DOE/EA–0911)
Proposed solar two project Barstow, California. USDOE Golden Field Office, CO (United States). Jan 1994. 55p. Sponsored by USDOE, Washington, DC (United States). Order Number DE94013082. Source: OSTI; NTIS; GPO Dep.

This Environmental Assessment (EA) evaluates the environmental consequences of the proposed conversion and operation of the existing Solar One Facility in Daggett, Ca, near the city of Barstow, to a nitrate salt based heat transfer system, Solar Two. The EA also addresses the alternatives of different solar conversion technologies and alternative sites and discusses a no action alternative. A primary objective of the Solar Two Project is to demonstrate the technical and economic feasibility of a solar central receiver power plant using molten salt as the thermal storage and transport fluid medium. If successful, the information gathered from the Solar Two Project could be used to design larger commercial solar power plants.

154
(SAND–93-1251)
On-sun test results from second-generation and advanced-concepts alkali-metal pool-boiler receivers. Moreno, J.B.; Andraka, C.E.; Moss, T.A.; Cordeiro, P.G.; Dudley, V.E.; Rawlinson, K.S. Sandia National Labs., Albuquerque, NM (United States). May 1994. 63p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE94011243. Source: OSTI; NTIS; GPO Dep.

Two 75-kW_t alkali-metal pool-boiler solar receivers have been successfully tested at Sandia National Laboratories' National Solar Thermal Test Facility. The first one, Sandia's " second-generation pool-boiler receiver," was designed to address commercialization issues identified during post-test assessment of Sandia's first-generation pool-boiler receiver. It was constructed from Haynes alloy 230 and contained the alkali-metal alloy NaK-78. The absorber's wetted side had a brazed-on powder-metal coating to stabilize boiling. This receiver was evaluated for boiling stability, hot- and warm-restart behavior, and thermal efficiency. Boiling was stable under all conditions. All of the hot restarts were successful. Mild transient hot spots observed during some hot restarts were eliminated by the addition of 1/3 torr of xenon to the vapor space. All of the warm restarts were also successful. The heat-transfer crisis that damaged the first receiver did not recur. Thermal efficiency was 92.3% at 750°C with 69.6 kW_t solar input. The second receiver tested, Sandia's "advanced-concepts receiver," was a replica of the first-generation receiver except that the cavities, which were electric-discharge-machined in the absorber for boiling stability, were eliminated. This step was motivated by bench-scale test results that showed that boiling stability improved with increased heated-surface area, tilt of the heated surface from vertical, and added xenon. The bench-scale results suggested that stable boiling might be possible without heated-surface modification in a 75-kW_t receiver. Boiling in the advanced-concepts receiver with 1/3 torr of xenon added has been stable under all conditions, confirming the bench-scale tests.

155
Solar Test Centre Almeria: Final report on SOTA project. (Solares Testzentrum Almeria: Berichte der Abschlusspraesentation des Projektes SOTA). Becker, M. (ed.) (Deutsche Forschungsanstalt fuer Luft- und Raumfahrt e.V. (DLR), Koeln (Germany). Hauptabteilung Energietechnik); Boehmer, M. (ed.); Funken, K.H. (ed.). 397p. C.F. Mueller, Karlsruhe (Germany) (1993). (In German).

Solar thermal energy has proved to be a particularly promising way of saving fossil fuels. Research was carried out at the Almeria solar platform from 1987 to 1991, in the context of the SOTA programme. This volume is the final presentation of the results in the context of a symposium. A

separate abstract was provided for all the 29 contributions made. (BWI)

156
The SOTA project, Solar Test Centre Almeria: Survey of the period 1987-1991. (Das Projekt SOTA, Solares Testzentrum Almeria: Ein Ueberblick ueber die Laufzeit 1987-1991). Becker, M. (Hauptabt. Energietechnik, Deutsche Forschungsanstalt fuer Luft- und Raumfahrt e.V., Koeln-Porz (Germany)). pp. 3-23 of Solar Test Centre Almeria: Final report on SOTA project. Becker, M. (ed.); Boehmer, M. (ed.); Funken, K.H. (ed.). C.F. Mueller, Karlsruhe (Germany) (1993). 397p. (In German).

This article is intended to give a survey of the aims, work and results of the SOTA Project (Solar Test Centre Almeria), which was carried out by the DLR on behalf of the German Ministry of Research and Technology. The following articles give some very detailed information. The project had a total extent of about 26 million DM over five years, where about 14 million DM were available for operation of the experimental plant in Almeria. About 3 to 4 million DM were used for accompanying scientific work and for the special experiments. (orig./BWI)

157
The construction of a European solar test centre 1979-1991. (Plataforma Solar de Almeria (PSA): Der Aufbau eines europaeischen Solartestzentrums 1979-1991). Grasse, W. (Hauptabt. 'Plataforma Solar', Deutsche Forschungsanstalt fuer Luft- und Raumfahrt e.V., Almeria (Spain)). pp. 25-44 of Solar Test Centre Almeria: Final report on SOTA project. Becker, M. (ed.); Boehmer, M. (ed.); Funken, K.H. (ed.). C.F. Mueller, Karlsruhe (Germany) (1993). 397p. (In German).

During the last twelve years, a solar test centre was constructed in Southern Spain, which offers European firms and institutions in Europe unique research and development services. The PSA is both a service centre for industrial and institutional research/development/demonstrations and an outside body similar to an institute of the solar research groups of both the parent institutes in Madrid and Stuttgart/Cologne. The areas of work of the PSA are: Solar thermal and photo-electric generation of electricity; Solar chemistry; Process heat; High termperature materials. (orig./BWI)

158
Aims, tasks and main results of the SOTA work package: Accompanying scientific work. (Ziele, Aufgaben und Hauptresultate des SOTA-Arbeitspaketes: Wissenschaftliche Begleitung). Funken, F.H. (Hauptabt. Energietechnik, Deutsche Forschungsanstalt fuer Luft- und Raumfahrt e.V., Koeln-Porz (Germany)); Schneider, G. pp. 45-53 of Solar Test Centre Almeria: Final report on SOTA project. Becker, M. (ed.); Boehmer, M. (ed.); Funken, K.H. (ed.). C.F. Mueller, Karlsruhe (Germany) (1993). 397p. (In German).

The 'accompanying scientific work' created the conditions for the construction and testing of prototypes of important components for solar thermal energy and the application of computer programs for the design and optimisation of optical configurations of focussing solar plant. The transfer of solar photo-chemical processes for the synthesis of fine chemicals and solar photo-catalytic processes to detoxify the contents of water on the technical scale showed the access, in principle, for exploiting an attractive market niche. There are concepts in existence for applications not yet tried. (orig.)

159
Operating experience with experimental solar thermal power plants in Spain and perspectives for near-term commercial applications. Grasse, W.; Macias, M.; Schiel, W. pp. 67-83 of Regenerative energies: Operating experience and profitability analyses of plants in Europe. VDI-Verl, Duesseldorf (Germany) (1993). 190p. (CONF-930368--: Renewable energy sources meeting: cost-benefit analysis and experiences gained in the operation of plants operated by renewable energy sources in Europe, Munich (Germany), 16-17 Mar 1993).

In Spain, all four technical concepts of solar thermal power plants have been built, operated and investigated in international cooperation. Experimental data were analyzed in a systematic manner. Results, summarized in this paper, indicate that there are good chances for near-term commercial applications of all 4 types of solar thermal power plants in the Mediterranean area and in other countries of the solar belt. Predictable cost of less than 0,30 or even 0,20 DM/kWh for generated electric energy can be close to competitiveness compared to conventional power plants already in near future. (orig.)

160
The open volumetric receiver - introduction and survey of the tests at the Almeria Solar Platform. (Der offene volumetrische Receiver - Einfuehrung und Ueberblick ueber Tests auf der PSA). Boehmer, M. (Hauptabt. Energietechnik, Deutsche Forschungsanstalt fuer Luft- und Raumfahrt e.V., Koeln-Porz (Germany)); Cordes, S. pp. 99-118 of Solar Test Centre Almeria: Final report on SOTA project. Becker, M. (ed.); Boehmer, M. (ed.); Funken, K.H. (ed.). C.F. Mueller, Karlsruhe (Germany) (1993). 397p. (In German).

Pipe receivers, volumetric receivers and direct absorbing receivers for solar tower powerstations are discussed. In the context of the SOTA programme, volumetric receivers in particular, are examined. In the introduction, this article explains the reasons which led to the development of this type of receiver. The construction and method of operation are also described. (BWI)

161
Program package for the simulation of volumetric receivers: Simulation of foil absorbers. (Programmpaket zur Simulation volumetrischer Receiver: Simulation von Folienabsorbern). Flouros, M. (Inst. fuer Thermo- und Fluiddynamik, Bochum Univ. (Germany)); Fiebig, M. pp. 131-139 of Solar Test Centre Almeria: Final report on SOTA project. Becker, M. (ed.); Boehmer, M. (ed.); Funken, K.H. (ed.). C.F. Mueller, Karlsruhe (Germany) (1993). 397p. (In German).

This article introduces work on the simulation of volumetric receivers and the simulation of foil absorbers, which was carried out in collaboration with the DLR at the Ruhr University at Bochum. In the introduction, the requirements for the simulation algorithm (heat transport mechanisms, conduction of heat, convection, solar radiation, thermal radiation, gas radiation, evaluation) are described. The calculation concept and the method of calculating the algorithm are then explained. Finally, the compatibility of the algorithm (temperature distribution for gas and wall, individual heat transport mechanisms, pressure loss, efficiency) are dealt with. (BWI)

162
The volumetric ceramic foil receiver. (Der volumetrisch keramische Folienreceiver). Cordes, S. (Hauptabt. Energietechnik, Deutsche Forschungsanstalt fuer Luft- und Raumfahrt e.V., Koeln-Porz (Germany)); Boehmer, M. pp. 141-154 of Solar Test Centre Almeria: Final report on SOTA project. Becker, M. (ed.); Boehmer, M. (ed.); Funken, K.H. (ed.). C.F. Mueller, Karlsruhe (Germany) (1993). 397p. (In German).

In the context of the SOTA project, various concepts of volumetric receivers were developed and tested at the PSA. This article describes examples of the development and testing of a volumetric ceramic foil receiver. The basis for the design of the absorber was heat transfer calculations, which were done for the various designs. Technically, the ceramic foil receiver is based on the manufacturing process which was used for highly efficient heat transfer at high temperatures. The material SiSiC is particularly suitable for this. (BWI)

163
Development work on a selective volumetric receiver. (Entwicklungsarbeiten zu einem selektiven volumetrischen Receiver). Pitz-Paal, R. (Lehrstuhl fuer Waerme- und Stoffuebertragung, Bochum Univ. (Germany)); Fiebig, M. pp. 155-168 of Solar Test Centre Almeria: Final report on SOTA project. Becker, M. (ed.); Boehmer, M. (ed.); Funken, K.H. (ed.). C.F. Mueller, Karlsruhe (Germany) (1993). 397p. (In German).

In the context of the work package 300 of the SOTA project, a new volumetric receiver concept was proposed, modelled, designed and constructed as a prototype by us and preliminary experimental investigations on strength and temperature resistance of individual components were carried out. An experiment for characterising the thermal behaviour of this new type of receiver at the solar experimental powerstation at Almeria was prepared, accompanied and evaluated. The investigations show the great potential of the selective volumetric receiver, but make clear the difficulties in the conversion of this concept into practice. (orig./BWI)

164
Comparison of the differences of volumetric receivers and possibilities of optimisation. (Vergleich der verschiedenen volumetrischen Receiver und Chancen der Optimierung). Cordes, S. (Hauptabt. Energietechnik, Deutsche Forschungsanstalt fuer Luft- und Raumfahrt e.V., Koeln-Porz (Germany)); Becker, M. pp. 169-181 of Solar Test Centre Almeria: Final report on SOTA project. Becker, M. (ed.); Boehmer, M. (ed.); Funken, K.H. (ed.). C.F. Mueller, Karlsruhe (Germany) (1993). 397p. (In German).

Different concepts of volumetric receivers were examined at Almeria in the context of the SOTA programme. This article presents the performance data of the different types of absorbers determined so far and compares the results. The aim of the comparison is to derive an understanding of the effective relationships in such a volumetric absorber from the empirical results and to work out targets for their further development. (BWI)

165
New type of concepts of solar electricity generation in small units (AMTEC, Solar Stirling Park etc.). (Neuartige Konzepte der solaren Stromerzeugung in kleinen Einheiten (AMTEC, Solar Stirling Park und andere)). Boehmer, M. (Hauptabt. Energietechnik, Deutsche Forschungsanstalt fuer Luft- und Raumfahrt e.V., Koeln-Porz (Germany)). pp. 183-196 of Solar Test Centre Almeria: Final report on SOTA project. Becker, M. (ed.); Boehmer, M. (ed.); Funken, K.H. (ed.). C.F. Mueller, Karlsruhe (Germany) (1993). 397p. (In German).

As photo-electric electricity generation is only economic and cheap for small applications, solar thermal energy is increasingly being proposed for applications in the range between 10 and 100 kW. The combination of a Stirling dish, where a Stirling engine with a generator connected after it, is fitted at the focal point of a paraboloid focusser, is favoured. In the context of the SOTA project, the AMTEC (alkali metal thermocouple converter) and the combination of tower and Stirling was examined. The article reports on research and development work for both these applications. (BWI)

166
Status and prospects of solar thermo-chemical processes. (Status und Perspektiven solarer thermochemischer Prozesse). Funken, K.H. (Hauptabt. Energietechnik, Deutsche Forschungsanstalt fuer Luft- und Raumfahrt e.V., Koeln-Porz (Germany)). pp. 197-205 of Solar Test Centre Almeria: Final report on SOTA project. Becker, M. (ed.); Boehmer, M. (ed.); Funken, K.H. (ed.). C.F. Mueller, Karlsruhe (Germany) (1993). 397p. (In German).

An examination was carried out in the context of the SOTA programme to what extent solar thermal plants can produce secondary energy sources which can be stored for basic industries via thermo-chemical processes. This will only be possible with systems which fix solar radiation into chemical energy with the best possible quality and most economically. In the context of the ASTERIX experiment, the interface between the solar and the conventional part of the plant was examined at the Almeria Solar Platform. Strategies for operating the solar/chemical plant analogous to a conventional chemical factory were also developed. The feasibility of coupling high temperature solar process heat with endothermal chemical reactions was proved. (BWI)

167
Thermo-chemical hydrogen production in solar sulphur/iodine process. (Thermochemische Wasserstoffproduktion im solarbetriebenen Schwefel-Jod-Prozess). Roth, M.; Knoche, K.F.; Poptodorov, H. pp. 207-220 of Solar Test Centre Almeria: Final report on SOTA project. Becker, M. (ed.); Boehmer, M. (ed.); Funken, K.H. (ed.). C.F. Mueller, Karlsruhe (Germany) (1993). 397p. (In German).

It is the aim of thermo-chemical process circuits to split water into hydrogen and oxygen with the aid of thermal energy. The chemical reaction occurs in stages in the thermo-chemical process, so that the required process temperatures of 2500 C are bypassed. The sulphur/iodine process is examined in the context of this article, where the key reaction is a Bunsen reaction in which gaseous sulphur dioxide reacts with liquid water and iodine. There is a total of three chemical reactions, one after the other. The course of the process and the technique of the individual steps are described in detail. (BWI)

168
Investigation of coupled thermal and photo-chemical dissociation of SO_3 at high temperatures. (Untersuchung der gekoppelten thermischen und photochemischen SOsub 3-Dissoziation bei hohen Temperaturen). Dzubiella, M.

(Technische Hochschule Aachen (Germany). Lehrstuhl fuer Technische Thermodynamik); Brueggemann, D.; Roth, M.; Knoche, K.F. pp. 221-243 of Solar Test Centre Almeria: Final report on SOTA project. Becker, M. (ed.); Boehmer, M. (ed.); Funken, K.H. (ed.). C.F. Mueller, Karlsruhe (Germany) (1993). 397p. (In German).

Absorption and Raman scattering experiments were carried out to examine light absorption and the decomposition reactions of sulphur trioxide, depending on the temperature and the effect of light. The results show that SO_3 absorbs light in the ultraviolet range of 200 to 300 nm. Due to absorption of radiation, sulphur trioxide is decomposed into SO_2 and O_2 at low temperatures. At the technically important higher temperatures, the effect of radiation favours dissociation of SO_2 in the initial phase of the reaction. First experiments on SO_3 irradiation with sunlight show that sulphur trioxide can be decomposed by solar radiation. (orig.)

169

Chemical resistance and strength of silicon carbide silicated in reaction under cyclic thermal loading. (Chemische Bestaendigkeit und Festigkeit von reaktionssiliziertem Siliziumkarbid unter zyklothermischer Belastung). Heider, W. (Cesiwid Elektrowaerme GmbH, Erlangen (Germany)); Foerthmann, R. pp. 245-256 of Solar Test Centre Almeria: Final report on SOTA project. Becker, M. (ed.); Boehmer, M. (ed.); Funken, K.H. (ed.). C.F. Mueller, Karlsruhe (Germany) (1993). 397p. (In German).

The aim of this project was to test the corrosion behaviour of two types of SiSiC with a maximum of 20 and 15% of free silicon respectively in as realistic conditions as possible for a solar thermal plat for generating hydrogen with the aid of the sulphur/iodine process, in order to be able to reliably judge the suitability of this ceramic material as a heat exchange material for this special application. (orig.)

170

Status and prospects of solar photo-reactions. (Status und Perspektiven solarer Photoreaktionen). Funken, K.H. (Hauptabt. Energietechnik, Deutsche Forschungsanstalt fuer Luft- und Raumfahrt e.V., Koeln-Porz (Germany)). pp. 257-268 of Solar Test Centre Almeria: Final report on SOTA project. Becker, M. (ed.); Boehmer, M. (ed.); Funken, K.H. (ed.). C.F. Mueller, Karlsruhe (Germany) (1993). 397p. (In German).

Several promising attempts at solar photo-chemical synthesis of chemicals relevant to industry were developed in the SOTA project. The SOLARIS experiment at the Almeria Solar Platform proved that fine chemicals could be produced on a small scale (several kilograms per day) with the aid of solar radiation. A small but fine market niche can be exploited in the short or medium term by solar photo-chemical synthesis of fine chemicals, because in conventional photochemistry, the light costs make up a substantial part of the total production costs. The chance of solar photo-chemistry is based on the fact that the sun delivers immediately useful radiation. (orig./BWI)

171

The SOLARIS-experiment: Demonstration of solar photo-chemical synthesis in a linear focussing collector at the Almeria Solar Platform. (Das SOLARIS-Experiment: Demonstration solar-photochemischer Synthesen in einem linienfokussierenden Kollektor auf der Plataforma Solar de Almeria). Scharf, H.D. (Technische Hochschule Aachen (Germany). Inst. fuer Organische Chemie); Esser, P.; Esser, P.; Woehrle, I.; Funken, K.H. pp. 287-307 of Solar Test Centre Almeria: Final report on SOTA project. Becker, M. (ed.); Boehmer, M. (ed.); Funken, K.H. (ed.). C.F. Mueller, Karlsruhe (Germany) (1993). 397p. (In German).

With the aid of the SOLARIS experiment, it was shown that sunlight, whose radiation energy lies in wavelength ranges up to 50%, can be used to initiate chemical reactions. Focussing systems are required for this purpose. For a solar-chemical production plant, the energy for operating the peripheral units should also be provided from solar sources. The photo-chemical potential of the sun was shown by three different test reactions with different absorption behaviour. (BWI)

172

Experience with the GAST ceramic panel. (Erfahrungen mit dem GAST Keramik-Panel). Becker, M. (Hauptabt. Energietechnik, Deutsche Forschungsanstalt fuer Luft- und Raumfahrt e.V., Koeln-Porz (Germany)); Boehmer, M. pp. 363-369 of Solar Test Centre Almeria: Final report on SOTA project. Becker, M. (ed.); Boehmer, M. (ed.); Funken, K.H. (ed.). C.F. Mueller, Karlsruhe (Germany) (1993). 397p. (In German).

The aim of the gas-cooled solar tower (GAST) technology program was to develop important components of such a powerstation and to test them at the Almeria Solar Platform. After two different types of heliostats including the associated field control and a metal receiver panel with a hot gas pipe for 800 C had been built and tested, the ceramic receiver panel was tested to conclude the GAST program. The article refers to the first test phase in 1987/88 and contains a short report on the most important events in operating this panel in the years 1991/92. (orig./BWI)

173

Summary and future solar thermal and solar chemical work in solar research. (Zusammenfassung sowie zukuenftige solarthermische und solarchemische Arbeiten in der Solarforschung). Becker, M. (Hauptabt. Energietechnik, Deutsche Forschungsanstalt fuer Luft- und Raumfahrt e.V., Koeln-Porz (Germany)). pp. 383-390 of Solar Test Centre Almeria: Final report on SOTA project. Becker, M. (ed.); Boehmer, M. (ed.); Funken, K.H. (ed.). C.F. Mueller, Karlsruhe (Germany) (1993). 397p. (In German).

Following the SOTA project, one can say that the support of solar thermal development has given the necessary opportunities. The aims contained in it were achieved within the financial limitations. However, it was finally found that both the accompanying scientific work (which is not being continued) and the experiments can only be continued on a modest scale. Finally, a survey is given on further activities in the field of solar thermal generation of electricity, solar process technique/chemistry/detoxification and the Cologne solar furnace. (BWI)

174

Solar cells and batteries with unusual selective coatings for combined supply of heat and electricity by solar power stations. Koltun, Mark M. (Krzhizhanovsky Power Engineering Institute, Dept. of Renewable Energy Sources, Photovoltaic Lab., Moscow (Russian Federation)). *Solar Energy Materials and Solar Cells (Netherlands);* 33(1): 31-40 (1 May 1994).

Optical coatings are used to increase the efficiency, extend the life, and to improve the electrophysical characteristics and stability of solar energy converters based on various physical principles, including semiconductor solar cells. When solar cells are placed on the exterior of collectors in photothermal systems, and generate both electric and thermal power, the optical coating applied to their surfaces gives them highly unusual selective properties, namely, reduced reflection of solar radiation (and high transparency in this part of the spectrum), which leads to higher integrated solar absorption coefficient, and enhanced infrared reflection which ensures that the thermal emission coefficient is as low as possible. Solar cells then not only generate electric power but, at the same time, covered by these coatings, act as selective optical surfaces for solar collectors.

175
Viable solar thermal electricity generation. Kaneff, Stephen (Australian National Univ., Canberra, ACT (Australia)). *Power Generation Technology (United Kingdom);* (1994 issue): 105-109 (1994).

The recent successful development of large cost-effective paraboloidal concentrating collectors; (400m^2 aperture) is making practicable the use of solar thermal systems on a mass scale for the provision of electricity and process heat. It has also introduced the potential for eventually providing most if not all of our fuel energy needs from concentrated solar energy via solar-modified fossil fuels, solar fuels, chemicals and solar biomass conversion. (11 figures) (Author)

176
A momentary look - the power station complexes SEGS I + II in the Mojave desert. Leidenfrost, W. *Sonnenenergie (Germany);* 18(5): 38-39 (Oct 1993). (In German).

Short communication SOLAR THERMAL POWER PLANTS/design; SOLAR THERMAL POWER PLANTS/ parabolic trough collectors; DESIGN; INFORMATION; HYBRID SYSTEMS; HEAT EXCHANGERS; STEAM GENERATORS; GAS TURBINES; ELECTRIC POWER; POWER GENERATION

177
Solar short-range heating systems - options, prospects and efficiencies of solar-supported interconnected heating systems. Hawemann, F. (Hawemann Solar, Dresden (Germany)). *Energieanwendung und Energietechnik (Germany);* 42(6-7): 304-307 (Jun-Jul 1993). (In German).

The use of interconnected solar systems is justified for applications involving heat to be available at a relatively low temperature level. The most suitable applications concern space heating and hot water supply. 40% of primary energy use in Germany goes into there applications; hence, solar-thermal systems may be expected to allow the combustion of fossil fuels and the associated production of carbon dioxide as greenhouse gas and of air-borne pollutants to be reduced greatly. (orig.)

178
Photovoltaic power supply for systems and apparatus in the low to medium output range. Roth, W. (Fraunhofer-Inst. fuer Solare Energiesysteme, Freiburg im Breisgau (Germany)). *Energieanwendung und Energietechnik (Germany);* 42(6-7): 316-322 (Jun-Jul 1993). (In German).

Examples are used to demonstrate that conventional power supply systems can be replaced by photovoltaic ones in many cases. Solar-powered systems by means of photovoltaics have the benefits of grid independence, handling case, reduced maintenance costs, and substitution of batteries with their pollution hazards. (orig.)

179
Novel collector systems for process heat and industrial hot water. Wagner, A. (Fraunhofer-Inst. fuer Solare Energiesysteme, Gruppe Leipzig (Germany)). *Energieanwendung und Energietechnik (Germany);* 42(6-7): 322-325 (Jun-Jul 1993). (In German).

Transparent thermal insulation (TTI) in collector technology allows available systems to be much improved in their efficiencies and to be used in new applications. The author provides a brief overview on novel collectors for industrial hot water and process heat generation, and on long-term storage tanks with transparent insulation. (orig.)

Central Receiver

180
(SAND–94-0095)
Detail design of a 10.4-m stretched-membrane dish: Phase 2, Final report. Sandia National Labs., Albuquerque, NM (United States); Solar Kinetics, Inc., Dallas, TX (United States). Jan 1994. 176p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE94009462. Source: OSTI; NTIS; GPO Dep.

This report describes efforts conducted under Tasks 3 and 4 of the second phase of the project to develop a single-element stretched-membrane dish concept to reduce the cost of a high-performance concentrating solar collector. We completed the detailed design for such a collector suitable to drive a 25-kWe Stirling motor generator. The design includes the collectors, optical element, the drive, and support systems. The aperture of the optical element was sized to provide the required energy to the engine based on test data and analytical models of the concentrator receiver, and engine. The design of the optical element was improved based on experience gained from the design, fabrication, and testing of several prototypes.

181
(SAND–94-8211)
Corrosion of stainless and carbon steels in molten mixtures of industrial nitrates. Goods, S.H. (Sandia National Labs., Livermore, CA (United States)); Bradshaw, R.W.; Prairie, M.R.; Chavez, J.M. Sandia National Labs., Livermore, CA (United States). Mar 1994. 37p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE94009866. Source: OSTI; NTIS; GPO Dep.

Corrosion behavior of two stainless steels and carbon steel in mixtures of $NaNO_3$ and KNO_3 was evaluated to determine if impurities found in commodity grades of alkali nitrates aggravate corrosivity as applicable to an advanced solar thermal energy system. Corrosion tests were conducted for 7000 hours with Types 304 and 316 stainless steels at 570C and A36 carbon steel at 316C in seven mixtures of $NaNO_3$ and KNO_3 containing variations in impurity concentrations. Corrosion tests were also

conducted in a ternary mixture of $NaNO_3$, KNO_3, and $Ca(NO_3)_2$. Corrosion rates were determined by descaled weight losses while oxidation products were examined by scanning electron microscopy, electron microprobe analysis, and X-ray diffraction. The nitrate mixtures were periodically analyzed for changes in impurity concentrations and for soluble corrosion products.

182
Calculations for volumetric foil receivers. (Berechnung volumetrischer Folien-Receiver). Freudenstein, K. (Siemens AG, Bereich Energieerzeugung (KWU), Bergisch Gladbach (Germany)). pp. 119-129 of Solar Test Centre Almeria: Final report on SOTA project. Becker, M. (ed.); Boehmer, M. (ed.); Funken, K.H. (ed.). C.F. Mueller, Karlsruhe (Germany) (1993). 397p. (In German).

The following work was carried out by INTERATOM, Bergisch Gladbach in 1986 to 1991 for the SOTA programme: 1) A feasibility study for ceramic foil receivers by means of a thermal technology single channel model; 2) The theoretical basis; 3) Design calculations on the basis of 1); 4) Design and manufacture of a further, modularly constructed metal/foil receiver by EMITEC. It was found that the single channel model for calculations produced for volumetric foil receivers was a suitable part of the test programme, on the one hand for evaluating the feasibility of such tests and on the other hand, for understanding the evaluation of the tests. (orig./BWI)

183
Performance of the CPG 7.5-kW$_e$ dish-Stirling system. Bean, J.R. (Cummins Power Generation, Inc., Columbus, IN (United States)); Diver, R.B. pp. 2.627-2.632 of Proceedings of the 28th intersociety energy conversion engineering conference. Volume 2 – Environmental impact, energy systems, new technology for energy utilization, policy issues, renewable energy sources, stirling cycles. American Chemical Society, Washington, DC (United States) (1993). 1005p. DOE Contract AC04-76DP00789. (CONF-930804–: 28. intersociety energy conversion engineering conference, Atlanta, GA (United States), 8-13 Aug 1993).

Through the Dish-Stirling Joint Venture Program (JVP) sponsored by the US Department of Energy (DOE), Cummins Power Generation, Inc., (CPG) and Sandia National Laboratories (SNL) have entered into a joint venture to develop and commercialize economically competitive dish-Stirling systems for remote power applications. The $14 million JVP is being conducted in three phases over a 4-year period in accordance with the Cummins Total Quality System (TQS) for new product development. The JVP is being funded equally by CPG, including its industrial partners, and the DOE. In June 1992, a concept validation (prototype) 5-kW$_e$ dish-Stirling system became operational at the CPG test site in Abilene, TX. And on January 1, 1993, the program advanced to phase 2. On the basis of the performance of the 5-kW$_e$ system, a decision was made to increase the rated system output to 7.5-KW$_e$. The CPG system uses advanced components that have the potential for low cost and reliable operation, but which also have technical risks. In this paper, the status of the advanced components and results from system integration testing are presented and discussed. Performance results from system testing of the 5-kW$_e$ prototype along with phase 2 goals for the 7.5-kW$_e$ system are also discussed.

184
Studies on solar-dish heated Stirling engines TNT-3, NAS-2. Isshiki, Naotsugu (Nihon Univ., Koriyama (Japan)); Watanabe, Hiroichi; Shishido, Koro; Ohtomo, Michihiro; Watanabe, Kuniya. pp. 2.645-2.650 of Proceedings of the 28th intersociety energy conversion engineering conference. Volume 2 – Environmental impact, energy systems, new technology for energy utilization, policy issues, renewable energy sources, stirling cycles. American Chemical Society, Washington, DC (United States) (1993). 1005p. (CONF-930804–: 28. intersociety energy conversion engineering conference, Atlanta, GA (United States), 8-13 Aug 1993).

Solar Stirling engine with simple dish concentrator is thought to be the best method to get power or electricity from solar beams for small and isolated applications in developing countries, because they have good efficiency and quick starting ability and they can be manufactured with low cost. Here the authors have been studying and developing successively, unique small solar Stirling engines called TNT (Tohoku Electric Power Co. Nihon Univ. and Tohoku-gakuin Univ.) 1, 2 and 3, also two solar dish concentrators A and B. Moreover atmospheric hot air Stirling engines NAS-1 and 2 are successively tested, which have rubber diaphragm power pistons and very simple constructions, the name coming from Nihon Univ., Atmospheric Stirling engine. The authors report on the recent studies on TNT-3, and NAS-2, and modifications of solar dishes.

185
Note on axial-flow sensible-heat solar-dynamic receivers. Lund, K.O. (Univ. of California, La Jolla, CA (United States)). *Journal of Heat Transfer (Transactions of the ASME (American Society of Mechanical Engineers), Series C) (United States);* 116(1): 273-275 (Feb 1994).

This note uses the Fast Fourier Transform method to analyze an axial-flow sensible-heat receiver, and compares its performance to phase-change material receivers. The model is applied to the Space Station conditions with a net average gain of 96.47 kW and inlet and average outlet temperatures of 797 K and 1012 K, for an electrical output of 32 kW. The rodded structure with flow tubes may not be best for sensible-heat receivers, but a circular "slab" or plate-fin of diameter D_R could be used. 10 refs., 3 figs., 2 tabs.

186
Phoebus experiments successful: Solar receiver tests up to expectations. Finker, A. (FDE, Stuttgart (Germany)); Schmitz-Goeb, M.; Streuber, C. *Energie Spektrum (Germany);* (11): 34-40 (Nov 1993). (In German).

This international project of solar energy conversion in a central receiver system was started in 1986. A feasibility study published in March 1990 shared that the volumetric air receiver principle is best suited as central receiver, owing to its technical and ecological advantages. Air as heat carrier in the primary cycle is also non-toxic, non-corrosive, easy to handle, and available in abundance. A receiver of this type was tested with good results in the Plataforma Solar de Almeria. Its design and function are described. (BWI)

Distributed Collector

187
(ENET–9107340/1)
Project of a mini power station in the Alps with extra-flat

collectors integrated in the structure of avalanche brakes. Allani, Y. (Ecole Polytechnique Federale, Lab. d'Energetique Industrielle, Lausanne (Switzerland)); Curti, V. Bundesamt fuer Energiewirtschaft, Bern (Switzerland). Sep 1992. 110p. (In French). Sponsored by Bundesamt fuer Energiewirtschaft, Bern (Switzerland). Source: ENET Administration und Versand, Postfach 142, CH-3000 Bern 6, Switzerland.

In this report an overview of the project is given, the results of circuits in Jeizinen (Canton of Valais) and at LENI in Lausanne are communicated, as well as discussions of the technical developments in view of the realization of a pilot plant. figs., tabs.

188

Exergy analysis and operating behaviour of solar-thermal steam turbine power plants with parabolic trough concentrators. Mikhael, N.N. (Mechanical Power Dept., Faculty of Engineering, Suez Canal Univ., Port Said (Egypt)); Wittig, S.; Willibald, U. pp. 103-124 of Turbomachinery utilization: Environmental responsiveness, operating safety, profitability. Dedicated to Prof. Dr.-Ing. Guenther Dibelius on the occasion of his 70th anniversary. Pitt, R.U. VDI-Verl, Duesseldorf (Germany) (1993). 229p.

The basic concept of a solar electric generating system (SEGS) plant with steam turbine is to supply a part of thermal energy via the solar field to produce a portion of the steam in a solar steam generator. The remaining steam is generated from a conventional boiler. The main concern of this paper is to investigate the possibility of extending a 30 MW capacity steam turbine plant as an SEGS plant, suiting the solar insolation data of Egypt. Design criterion of line-focus parabolic trough solar collector field with heat transfer fluid system is given, based on the exergy method of energy system analysis. The mutual influences between the solar field and the power plant working cycle and components are identified via a computed example. The computer codes developed enable the matching of the collector field and the solar steam generator with the conventional boiler and the turbine. The daily operating behaviour of the plant for hybrid mode of steam generation is simulated for the cases of constant load operation. The effects of the plant size and collectors aperture area on the percentage of fuel saving due to solar assessment are also indentified. Finally, the possibility of installing this type of SEGS plant in Egypt on a commercial scale is discussed. (orig.)

Total Energy and Hybrid Systems

189

Solar thermal repowering of coal-fired power plants. Bensinger, C. (Advanced Energy Systems, Santa Fe, NM (United States)). *Solar Today (United States);* 7(6): 20-22 (Nov-Dec 1993).

Repowering coal-fired power plants with cost-effective solar thermal technologies would have positive environmental and social impacts in the southwestern US. Topics discussed include solar thermal hybrids, candidate solar thermal technologies, the economics of repowering, and the advantages of solar/gas repowering.

AGRICULTURAL AND INDUSTRIAL PROCESS HEAT

190

(CONF-931269–, pp. 117-120)

Characteristics of a greenhouse with underground heat exchange system and reflecting wall. Yoshioka, T. (Kumano Technical College, Mie (Japan)); Taga, M.; Ochi, T. Japan Solar Energy Society, Tokyo (Japan). 9 Dec 1993. 323p. (In Japanese). From 1993 JSES/JWEA Joint Conference and '93 Japan-Korea Joint Conference on Solar Energy; Tsukuba (Japan); 9-10 Dec 1993. In *1993 JSES(Japan Solar Energy Society)JWEA(Japan Wind Energy Association) Joint Conference and '93 Japan-Korea Joint Conference on Solar Energy(December9and10,1993).* Order Number DE94767725. Source: OSTI; NTIS; Available from Japan Solar Energy Society, Sun Patio 322, 1-5, Takatanobaba 3-chome, Shinjuku-ku, Tokyo, Japan.

Effect of making the north side wall of a greenhouse reflective was sought experimentally to improve heat storage efficiency in the greenhouse. The greenhouse has an effective ground area of 30.8 m^2, and the area of reflective north side wall made of a vinyl chloride sheet attached with aluminum foil of 32.3 m^2. Incident energy out of the total heat amount received on the ground surface was calculated to be 25.7%. The experiment has been carried out during the period from December 10, 1992 to March 3, 1993 under a condition of a circulation fan operated around the clock and the greenhouse having no cultivated plants in it. As a result, the average heat storage efficiency in January was 12.69% in the greenhouse with a reflective wall, and 7.27% in a greenhouse without a reflective wall. The values for February were 15.2% and 12.2%, respectively, thereby the effect of the reflective wall was verified. Larger effect of the reflective wall in January was assumed because the reflective wall was installed vertically, so that the effect of the sun's altitude being lower in January was more prominent. 5 refs., 11 figs., 1 tab.

191

(CONF-931269–, pp. 121-124)

Study on the optimal control of the ground thermal storage system in the greenhouse. Zheng, M. (Nagoya University, Nagoya (Japan). Faculty of Engineering); Nakahara, N. Japan Solar Energy Society, Tokyo (Japan). 9 Dec 1993. 323p. (In Japanese). From 1993 JSES/JWEA Joint Conference and '93 Japan-Korea Joint Conference on Solar Energy; Tsukuba (Japan); 9-10 Dec 1993. In *1993 JSES(Japan Solar Energy Society)JWEA(Japan Wind Energy Association) Joint Conference and '93 Japan-Korea Joint Conference on Solar Energy(December9and10,1993).* Order Number DE94767725. Source: OSTI; NTIS; Available from Japan Solar Energy Society, Sun Patio 322, 1-5, Takatanobaba 3-chome, Shinjuku-ku, Tokyo, Japan.

Theoretical analysis was given on an optimal operation control of the ground thermal storage system to store solar energy for the purpose of saving energy in the system operation and providing a temperature environment optimal for growth of plants. A mathematical model for the ground thermal storage greenhouse was prepared on a greenhouse having no cultivated plants in it to verify its applicability. The restrictive condition is the minimum greenhouse temperature for plants to grow normally. Three kinds of performance

functions were discussed: one that is intended for a maximum energy conservation, another one that provides a temperature environment optimal for plants to grow in the greenhouse, and still another one that accounts for both of energy and environment. According to an example calculation for ground thermal storage greenhouse having 20 ducts, the operation schedule optimal for energy conservation was found to operate the fan for eight hours from 22:00 PM to 6:00 AM when the lower limit for the room temperature is 7°C as the restrictive condition. An optimal fan operation control was also decided on for a case when the weight ratio of a temperature environment optimal for tomato growth to energy conservation is assumed 10:1. Successive trial calculations have been verified the reasonability of the decision. 6 refs., 4 figs., 2 tabs.

192
(ECOFYS–E-177)
Drying and storage by means of solar energy in the bulb sector in the Netherlands. Schulte, B.; Out, P.G.; Van der Leun, C.J. Ecofys Cooperatief Advies- en Onderzoeksbureau UA, Utrecht (Netherlands). Nov 1993. 47p. (In Dutch). Project NOVEM 143.300-012.1. Source: Available from ECOFYS, Postbus 8048, 3503 RK Utrecht (Netherlands).

Heated ventilation air is used in the bulb sector to dry, store and condition the flower bulbs. Options to preheat the ventilation air by means of cheap and simple solar collectors are discussed. It has been calculated that solar collectors can be applied without subsidies. The payback period is 10-14 years. Circa 25 m^3 natural gas per m^2 solar collector can be saved per year. Based on the results of the calculations rules of thumb are formulated by which a bulb breeder or solar collector installer can simply dimension a solar collector for a bulb-growing cultivation. By means of the rules of thumb the feasibility of a solar energy system in five bulb-growing cultivations has been determined and the results are compared with the calculated energy demand of five imaginary bulb-growing businesses. It appeared that in a number of cultivations a lot of energy is also used for heating the bulbs. In that case the efficiency of the solar collector is much higher: a payback period of 4-5 years, circa 50 m^3 natural gas per m^2 solar collector can be saved per year. It is recommended to stimulate the use of solar energy in drying, storage and heating of bulbs in the Netherlands. 17 figs., 20 tabs., 2 appendices, 7 refs.

193
(KTM/E-B–157)
OPTIMITURVE - Peat production based on solar energy: Final report on the energy research programme 1988-1992. Leinonen, A. (Technical Research Centre of Finland, Jyvaeskylae (Finland). Combustion and Thermal Engineering Lab.); Erkkilae, A. Ministry of Trade and Industry, Helsinki (Finland). Energy Dept. 1994. 140p. Project KTM-275/881/87. Order Number DE94771071. Source: OSTI; NTIS.

Published in Finnish as the report KTM/E-B–156.

The aim of the Optimiturve research programme was to develop a peat production method based on solar energy, the efficiency and the profitability of which would be twice as high as those of previous methods. Due to the efficiency, which means a higher peat yield per hectare, the circulation of the capital invested in peat production increases and further boosts the competitiveness of peat. It was calculated that if the target of the research programme can be fulfilled, peat production costs could be reduced by 20 %. The total budget of the programme amounted to 44,3 million FIM. Basic knowledge for ditching of the bog, drying of milled peat, milling, pneumatic harvesting, drying of sod peat, maceration and excavation have been developed in the course of the Optimiturve research programme. Additionally, peat production planning and control have been studied and developed. A new milled peat production method, the so called TEHOTURVE method, and a new combined production method for milled and sod peat, the MULTI method, have been developed on this basis. The guiding principle of the TEHOTURVE method is that the average grain size of the milled layer to be dried increased from 5 mm to 15 mm and the collection coefficient of the ridger increased from 50 % to 80 %. Ridging of several harvests on the same ridge, efficient loading and driving are also typical of the method. The MULTI method is a combined production method for milled and sod peat. The method is based on sod peat production using the ridge drying method (TUPLA), in which two harvests are produced simultaneously. The first harvest is dried on the field and the other on the ridge.

194
Solar-augmented foam-mat drying of fruits. Tayeb, A.M. (El-Minia Univ. (Egypt). Faculty of Engineering). *Renewable Energy (United Kingdom);* 4(3): 283-289 (Apr 1994).

The foam-mat drying technique is used to dry fruit syrups into powder. Literature has indicated that solar energy has not yet been used in this field. Thus, it is the object of the present work to dry the foamed syrups of different fruits in a solar energy augmented drying unit. This leads to a saving in both energy and environmental pollution. An auxiliary heater along with a control unit, is used to ensure drying at constant temperature. Foaming is effected by suitable edible additives and in some cases a stabilizer is needed as well. The drying experiments were run on orange, lemon, grapefruit, tomatoes, strawberry, guava and apple. The results showed that foaming decreased the time of drying by 30.8-41.5% in the case of direct sun drying and by 47.1-73.2% in the case of solar drying compared to the drying time of unfoamed syrup. The study showed that the technique proves to be of sufficient efficiency and acceptability to replace spray drying. (author)

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