Review of Recent Developments in Solar Heat for Industrial Processes

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Content and Acknowledgements

Content:
- Motivation
- Market potential
- Challenges
- Recent and current projects
- SHC/SolarPACES Task 49/IV
- Concluding remarks

Thanks for contributions from:
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Renewable Energy Technologies for Power Generation

- Hydro
- Tidal
- Wave
- Solarthermal
- Biomass
- Photovoltaic
- Wind
- Geothermal
Renewable Energy Technologies for Process Heat

- Geothermal
- Concentrating Solar
- Biomass
- Non-concentrating Solar
Total Process Heat Demand
280 TWh/a
after 20% energy savings
Process Steam Demand by Industry Sectors

Total: 113 TWh/a (after 20% energy saving)
Challenges in Solar Process Heat

- Heat cannot be transported easily over long distances
  - Meteorological conditions at the site
  - Availability of suitable areas for collectors (ground, roof, facades)

- Solar field size (= investment cost) proportional to heat demand
  - Rational use of energy minimizes heat demand
  - Process optimization more cost effective than “free” solar energy

- Collector efficiency temperature dependent
  - Selection of suitable collector technology
  - Integration of solar heat at appropriate temperature

- Annual, daily and stochastic variations of radiation
  - Load management, heat storage or conventional back-up
  - Similar load and radiation profiles may increase solar share

- O&M effort for additional technology
  - Priority for O&M personnel: Efficient production
  - Fully automated solar operation
Direct steam supply to selected processes

- Optimized temperature level
- Separate solar heat system
  - Steam distribution
  - Condensate return
  - Feedwater treatment
  - Safety features
- Back-up Control
- Process demand profiles
- Storage requirements
Indirect steam supply via existing steam distribution

- Utilisation of existing infrastructure
  - Steam Distribution
  - Condensate return
  - Feedwater treatment
- Simple back-up control
- High security of supply
- Increase of potential solar share
- Improved solar capacity factor
- Reduced storage requirement
High pressure steam for co-generation

- Exploitation of exergy potential of concentrating collectors
- Added value from electricity production
- Increased investment
- Increased complexity

- Option: hybrid co-generation
Recent and current Projects

*EU InSun Project (started early 2012):*
*Solar Process Heat demonstration plants in 3 different industries*

Co-ordinated by zafh.net
Centre of Applied Research Sustainable Energy Technology at University of Applied Sciences Stuttgart

Dr. Dirk Pietruschka
InSun
Meat Factory Berger, Austria/Sieghartskirchen

Key data
- 1077 m² Flat Plate Collectors (glutamugl HT)
- 60 m³ hot water storage tank

Hot water preheating for dehumidification of maturation chambers
- 5 – 10 m³/h hot water demand
- Usage of waste heat until 40°C
- Solar heating up to 70°C

Preheating feed water for steam production (ham cooking)
- 3 m³/h hot water demand
- Usage of waste heat until 30°C
- Solar heating up to 95°C
InSun
Brick drying at Laterizzi Gambettola, Italy

Key data
- 2.640 m² Linear Fresnel Collector (Soltigua FTM36)
  - 1.056 m² Thermo oil / HX steam generator
  - 1.584 m² Direct steam generation
- Peak solar field capacity: 1,2 MW

Application:
- Brick drying at 200 to 260° C
- Steam production at 180° C (12 bar) for air preheating and to supply the steam driven radiant heat exchangers in the new innovative brick dryers.
- Required total heating power: 2.2 MW
- Heating energy demand: 12 GWh/a
InSun
Brick drying at Laterizzi Gambettola, Italy

Ground Preparation and Collector Field Installation, Status End of August 2012
InSun
Milk powder production at Lácteas Cobreros (LACO) 
Castrogonzalo-Zamora, Spain

Key data
- 2,040 m² Parabolic Trough Collector (Smirro)
- Solar field design capacity at 200° C: 1 MW
- HTF: Thermal oil

Application:
- Milk Powder drying at 185° C (120-150 d/yr)
- Production capacity: 2000l milk per day
- Pasteurizing processes and water heating
- Steam production at 195° C
- Required total heating power: 1,5 MW (24 h/d)
- Heating energy demand: 35 MWh/d
InSun
Milk powder production at Lácteas Cobreros (LACO)
Castrogonzalo-Zamora, Spain
Condensed and Powder Milk Production
InSun
Milk powder production at Lácteas Cobreros (LACO)
Castrogonzalo-Zamora, Spain

Smirro 40 kW reference plant in Germany

LACO plant schematic
Recent and current Projects

**NEP Solar** Emmi solar process heat plant on the Tête de Moines cheese factory in Saignelégier, Switzerland.
Hot water/antifreeze circuit, 130°C
627m², 400kW nominal heat capacity
Recent and current Projects

**NEP Solar:** Ewz / LESA solar process steam plant in Bever, Engadin, Switzerland, Commissioned Nov. 2011

**Quick Facts**
- 4x NEP Solar PolyTrough1200
- 116m², 70kW
- thermal oil circuit, 180-200°C supply temperature
- 4-6bar saturated steam production in tube-and-shell steam generator
- Injection of steam in existing steam network of milk processing plant
Recent and current Projects

**Industrial Solar:** Dürr Paint Oven
Bietigheim-Bissingen, Germany
Industrial Solar Installation at Dürr

6 modules • 132 m² aperture area • 24 m length • 7,5 m width
16 bar pressurized water circuit • 74 kW thermal peak power
ABENGOA SOLAR INC.

- Process heat
- Frito Lay (PepsiCo)
- Modesto, California, USA
- Operational 2008
- 5.068 m²
- 250°C, 41bar
- Indirect steam generation

- Back-up by natural gas fired steam generators

- Heating of oil used for cooking corn and potatoe chips

- Largest industrial solar thermal system in US
ABENGOA SOLAR INC.

- Process heat
- Steinway and Sons
- Long Island City, New York, USA
- Operational 2010
- 501 m²

- Back-up by natural gas

- Heating and cooling, process steam

- Humidity control of piano „action“ department
IEA SHC Task 49/IV: Solar process heat for production and advanced applications

Task lead: AEE INTEC (Christoph Brunner)
Joint Task with SolarPaces (Klaus Hennecke – DLR)

Start 2012, Duration 4 years

- **Subtask A:** Process heat collector
  (Dr. Elimar Frank - SPF)
- **Subtask B:** Process integration and Process Intensification combined with solar process heat
  (Bettina Muster – AEE INTEC)
- **Subtask C:** Design Guidelines, Case Studies and Dissemination
  (Dr. Werner Platzer – Fraunhofer ISE)
Concluding Remarks

- Industrial heat applications are a significant potential market for concentrating solar technologies
- Suitable collector technologies are offered by a number of suppliers
- First demonstration projects have been realized, or are under development
- Challenges remain:
  - System Integration / Optimization
  - Plant engineering
  - Collector improvements
  - Competitiveness with other heat sources / Incentive schemes

- The joint SHC/SolarPACES Task 49/IV provides a good forum for cooperation
  - Task Website:  www.iea-shc.org/task49/
  - Contact: klaus.hennecke@dlr.de

- Next Task meeting: SPF, Rapperswil, Switzerland, February 4-6, 2013
- SHC Conference 2013, Freiburg, Germany, September 23-25, 2013

Hope to see you there!