

M.Sc. Thesis position opening

Identification and performance test of reflective and solar insulating materials for Energy Efficient Buildings in UAE

Background

The total energy consumption of buildings, both residential and commercial, has steadily increased over the years, reaching figures between 20% and 40% of global energy demand for developed countries. Due to the hot-humid climate of UAE region, the energy share of buildings is even higher due to a constant cooling requirement for thermal comfort. Therefore, energy efficiency in buildings is of prime importance in terms of energy saving potential. A main contributor is the HVAC system, which can use more than 60% of the total building energy consumption. This cooling load can be reduced through the use of reflective coatings and insulation materials, which mitigate the flow of energy through the building and reduce its total energy consumption.

As a part of our building energy efficiency research, in 2010 CSEM-UAE developed a Solar Coating and an indoor calorimetric test facility. In 2011 the design of an outdoor test facility to quantify the energy savings of different building materials was completed, and simulation software was specifically developed for this purpose by a master's thesis student from Department of Energy Technology, KTH. As a continuation of this research, in 2012 CSEM-UAE will build an outdoor calorimetric test facility to evaluate several types of materials for Green Building design in real conditions.

Purpose

Based on csem-uae research and previous studies, the proposed master thesis will investigate and identify energy efficient, cost competitive Green Building construction elements adapted to hot-humid climates. Testing method(s) will be chosen to study the behavior of such materials in real conditions over a period of time.

Objectives

- Identify, procure, and install energy efficient building construction materials in the test facility
- Verify the material thermal properties under transient indoor conditions
- Quantify the comparative energy saving due to insulating and reflective coating materials under steady state condition
- Study the feasibility and cost effectiveness of implementing these materials in new buildings, as well as to retrofit existing buildings

Method of attack

Conduct literature and market review to identify efficient materials. Set up instrumentation to evaluate the energy saving of materials. Conduct experiments in csem-uae facilities. Compare results to simulations using Specific software and TRNSYS. Study the feasibility of using the materials in new or to retrofit buildings.

M.Sc. Thesis position opening

Solar Cooling System performance evaluation

Background

Due to the abundance of solar radiation, the approach of using the sun radiation for direct solar cooling to produce the Air Conditioning (AC) could be one of the most sustainable cooling solutions for the Middle East and the Gulf countries like the United Arab Emirates (UAE). In these countries, summer time, when the cooling demand is high due to the high ambient temperature and high level of solar radiation, the use of solar heating to generate the AC can be well matched with the high level of solar radiation.

The high fix initial investment cost, the lack of incentives for renewable energy promotion and the low cost of electricity generated by power plants using cheap fossil fuel, operating a small scale solar cooling system can be elusive even in UAE good climate conditions where vapor compression systems is still dearer to customers.

In order to identify the potential of economy of scale and to define the competitive size of a Solar Cooling Systems, in 2010, CSEM-uae achieved building and testing a solar cooling R&D facility with cooling capacity of 1 TR (Ton of Refrigeration). In 2011, this facility is extended to 10 TR and, depending on test and characterization, can be extended beyond this capacity.

Purpose

The proposed master thesis will experimentally evaluate the performance of two installed solar cooling systems consisting of two single effect absorption chillers and supplied with heat from 60 kW vacuum tubes solar collectors' field equipped with all necessary sensors and data acquisition set up.

Objectives

As a function of daily solar radiation

- Evaluate the thermal performance of the solar collectors' field
- Evaluate the thermal performance of 1 TR solar cooling system
- Evaluate the thermal performance of 10 TR solar cooling system
- Compare to theoretical prediction and propose competitive improvements

Method of attack

Review and identify the theoretical performance. Operate the cooling system according to needed measurements. Measure, log, collect and analyze the data. Calculate the performance including uncertainty analysis. Present the results in compliance with the standard engineering measurement and compare to theoretical prediction.

M.Sc. Thesis position opening

Characterization of Linear Fresnel Mirrors module for Concentrated Solar Power applications

Background

CSEM UAE has a focus towards renewable energy applied research. It has been diversifying its efforts towards innovative CleanTech application development which can cater local as well as global energy needs. One project was to design low cost-high performance solar tracker module for Linear Fresnel Mirrors (LFM) for Concentrated Solar Power (CSP) application; another was to evaluate the sensitivity of LFM design to assembly precision. In 2011, part of these research was carried at master's thesis level with two students from Offenburg University, Germany.

The proposed design is a LFM module of 64 m² with concentration factor of 80 suns and thermal power peak of 12 kW. The assembled galvanized steel structure will have limited circular movement on a rail system. Two of its wheels will be connected to a motor gear assembly. The system will be tracking the sun very precisely by calculating the position of the sun with respect to the fixed co-ordinates of the module, checking the position of the module and undergoing the correction accordingly. Upon reaching the desired evening set-point, the module will go back to the starting position and similar process will be carried out on the subsequent day. The module will incorporate cleaning system of the glass mirror fitted on the module. This system should be designed or selected for its simplicity, robustness, low power consumption and low cost.

Purpose

As a continuation, the proposed master's thesis will evaluate, integrate, characterize and fine-tune the precision components on the described Linear Fresnel Solar Concentrator module.

Objectives

- Evaluate, integrate and characterize a high precision solar tracking system
- Integrate and characterize the designed optical mirrors on the solar taker
- Design, integrate and characterize an efficient low power automatic mirrors cleaning mechanism

Method of attack

Understand and validate the LFM Solar Concentrator Module design and structure implementation. Fine-tune the assembly and measure the optical efficiency of the Fresnel Mirrors. Review literature and market of high precision low power solar tracking and automatics mirrors cleaning systems. Review or validate previous selection, implement, test and characterize.

M.Sc. Thesis position opening (Extendable to PhD Thesis)

Low cost / high performance Linear Fresnel Receiver design for Concentrated Solar Power applications

Background

Linear Fresnel Concentrators (LFC) is used to produce low temperature (150-350°C) water/steam that can be directly coupled to a steam turbine for electrical power generation or to an absorption chiller for cooling or for process heating. LFC use low or no curvature mirrors. Their low cost, flat shape, easy cleaning and better land use, than parabolic-trough or power tower, make them attractive but they lack records.

LFC Solar Concentrated Power (CSP) plant is similar to a fossil fuel operated plant. Its central element is the receiver, a horizontal solar radiation absorption tube, with or without secondary focusing mirrors, in the focus line of the LFC. Many working fluids can be considered. The most innovative is Direct Steam Generation (DSG) using water/steam not only as working fluid in power blocks but also as heat transfer fluid in the receiver. Beside the hot water related corrosion; the coexistence of two-phases (liquid-vapor) in the receiver brings additive instabilities. Stratification of fluid, leads to non-homogenous temperature distribution; this will generate thermal stress and results in bending, defocusing and failure. The control of the outlet steam parameters (temperature pressure...) is also more difficult. Receiver can be designed with selective coating to increase its absorption rate and to reduce its heat emissivity. The coating will operate in high temperature and severe weather conditions. The receiver will also lose heat by convection. This will be aggravated by the wind.

Some of LFC technology promoters (Industrial Solar) use expensive but well established Glass-vacuum tube protected receiver (Schott Solar). Although durability of selective coatings, in direct contact with atmospheric air, is not well known; most of the other promoters use cavity receivers without vacuum tubes. Designs consist of a single (Novatec Biosal, Solar Power Group) or multiple horizontal (Ausra (Areva)) absorber tubes aligned on the longitudinal focal axis of the LFC.

Purpose

The proposed master thesis will design and optimize a low cost high performance receiver for DSG –LFC for CSP module(s) of csem-uae solar Island platform.

Objectives

- Design receiver tube for DSG, defining its material, coating, size and shape
- Design its thermal insulation and secondary reflector considering wind effect

Method of attack

Review designs and performance of existing receivers and csem-uae CSP-module for Solar Island. Conceive simulated, compare and validated an optimum design of low cost / high performance DSG solar receiver tube with its coating, insulation and secondary reflector.