Solar Energy System Application at ADNOC Facilities

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1. Introduction

The UAE is abundant with solar energy which could be put into effective use for power generation and solar cooling. The utilization of the solar energy would reduce the country's dependence on fossil fuel. The purpose of this project is to develop suitable solar energy technologies that can be utilized effectively in the U.A.E. and the gulf region. The first step toward this goal is to measure the solar radiation levels, both direct normal and global radiation. The effort has been started and different meteorology devices such as, pyranometer and pyrheliometer, are being used to observe the weather conditions and measure the available solar irradiance. At the same time, the examination of the various solar cooling and power generation technologies is being made. Based on the data obtained during the first Phase, the most promising solar cooling/power generation options will be researched further through prototype testing and ultimately through field tests.

2. Key Solar Technologies

Solar absorption refrigeration system. In the absorption refrigeration cycle, the solar heat is used to operate the vapor generator of the refrigeration units where heat is added to the high-temperature part of the unit. In addition, the solar heat could be used to load the evaporator in the case of heat pumps where heat is added to the low-temperature part of the unit. Fig. 1 shows the main parts of an absorption refrigeration unit.

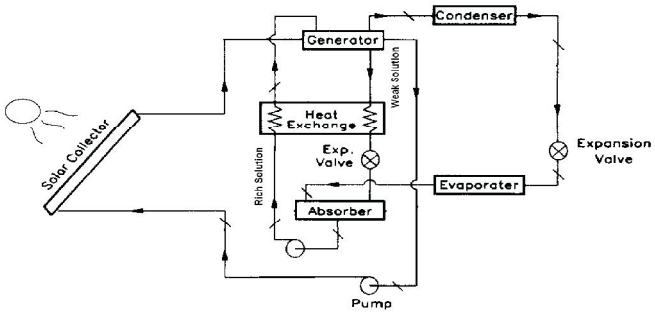

Fig. 1. Main Parts of an Absorption Refrigeration Unit.

Solar electric power generation system. There are two types of solar power generation systems available, solar thermal and photovoltaic systems. Figs. 2-4 depict some of the systems to be considered for this project.

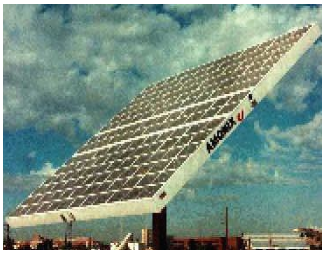

Fig. 2. PV system.

Fig. 3. Trough system.

Fig. 4. Dish/Engine system.

3. Status of the Program

Several instruments are being used to measure global and direct normal solar irradiance, air temperature, wind speeds/directions as shown in Figs. 5 and 6. Examples of the data are shown in Fig. 7. These data will be utilized to determine the most suitable solar energy systems to be used in this region.

Fig. 5. Dynamometer.

Fig. 6. Pyrheliometer with tracker.

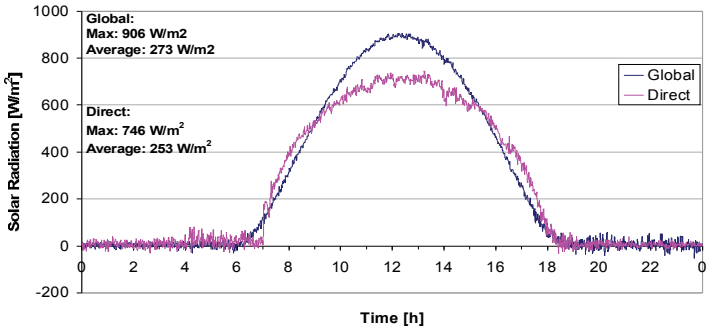

Fig. 7. Direct and global solar irradiance on a horizontal surface.

4. References and Bibliography

1. Sahin, A., Aksakal, A., and Sunar, M., 1999, "Solar-energy Availability in the North-eastern Arabian Peninsula," Applied Energy, vol. 18, pp. 323-329.
2. Thekaekara, M., 1976, "Solar Radiation Measurement: Techniques and Instrumentation," Solar Energy, vol. 18, pp. 309-325.

Author Biographies

Mr. Ali Al Alili is a Research Assistant in the Mechanical Engineering Program at the Petroleum Institute (PI), Abu Dhabi, UAE. He earned his degree in Mechanical Engineering from Arizona State University, USA. His current research interest is solar cooling techniques.

Dr. Isoroku Kubo is an Associate Professor in the Mechanical Engineering Program at the PI. He is an expert in energy conversion, heat transfer and fluid flow and an internationally recognized authority for his work in the solar energy-driven power generation. Dr. Kubo has many years of industrial experience in the areas of diesel engine R&D, solar energy system development as well as management and general product development. In 2001 he joined McNeese State University (MSU) in the U.S. before coming to the PI in December, 2004. Dr. Kubo holds an MBA degree from Indiana University, in addition to his Ph.D. in Mechanical and Aerospace Engineering from Cornell University.

Mr. Paul Kalinowski is a Research Assistant in the Mechanical Engineering Program at the PI. He completed his B.S. degree in Mechanical Engineering from the University of Applied Sciences Mannheim, Germany. He is currently working on several projects related to sustainable energy.

Dr. Reinhard Radermacher is a Professor in the Department of Mechanical Engineering at the University of Maryland, USA. He holds an M.S. and Ph.D. in Physics from the Munich Institute of Technology, Germany. Dr. Radermacher is an internationally recognized expert in heat transfer and working fluids for energy conversion systems, including heat pumps, air-conditioners, and refrigeration systems.