SOLHEATCOOL

Study and Development of Heating Systems using Renewable Energy

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Project Information

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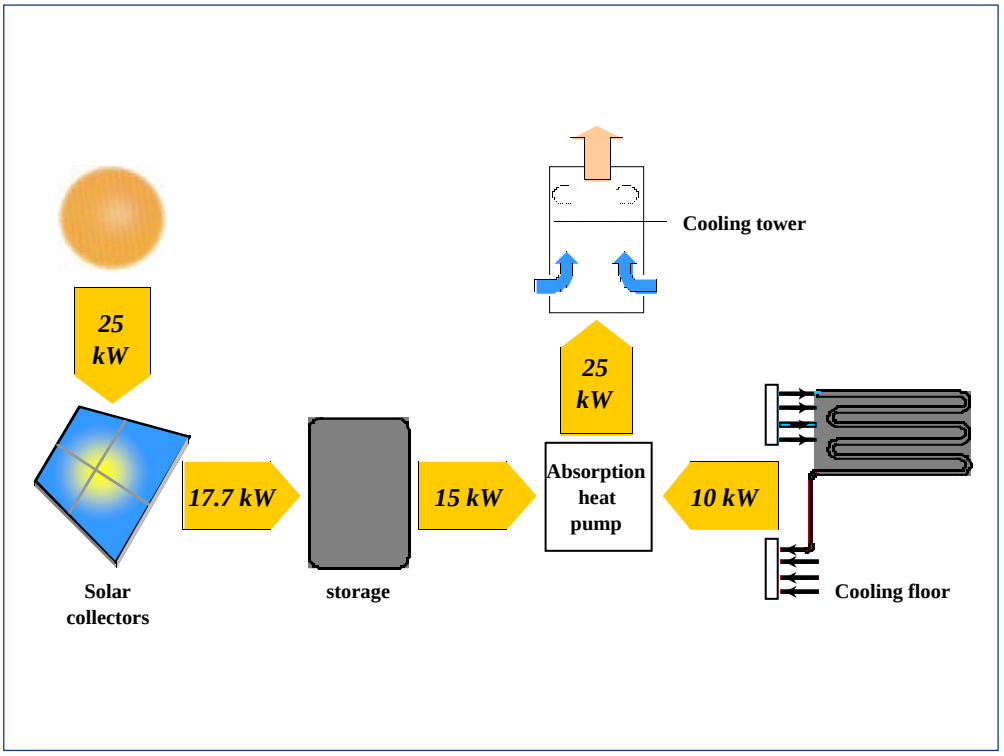
Project Partners:
D.F. Liedelt Velta Produktions, Germany
Jacques Giordano Industries, France
Zae Bayern, Germany
National Observatory of Athens, Greece

Project Co-ordinator:
COSTIC
(Comité Scientifique et Technique des Industries Climatiques)
Rue A Lavoisier – Z1,
Saint Christophe
04000 Digne, France
e.michel@costic.com
www.costic.assoc.fr

Research Directorate General
European Commission



Heating / cooling system with absorbent heat pump

The SOLHEATCOOL Project

The objective was to develop a reversible heating / cooling system, for small and medium sized buildings of around 300 m² floor area, that could help to minimise fossil fuel-based energy use, reduce electricity demand on the national grid especially at peak demand periods in summer and eliminate the use of CFCs. The system incorporates a solar thermal collector, an absorption heat pump, a cooling tower and a heating / cooling floor. The research work involved the analysis of high performance solar collectors, lithium-bromide / water absorption heat pumps, conventional heat pumps, radiant floor systems operating in cooling mode and the operation of the whole system including response times. Component analysis was undertaken using a climatic test cell and a major objective was to achieve a heat exchange coefficient of approximately 7W/m²K.

Background

The use of conventional air-conditioning systems is increasing at an alarming rate, especially in southern European Member States. It causes electricity supply problems in summer, wastage of finite fuel stocks due to electricity generation and transmission losses and contributes considerably to increased environmental pollution and global warming through greenhouse gas emission resulting from the burning of fossil fuels in electricity generation. The use of CFC gases that can escape to the atmosphere during manufacture, operation and disposal of conventional air-conditioning systems also poses a significant environmental risk.

CORTEC Solar collector prototype

The Solar Collectors

Measurement of the performance of a range of prototypes was undertaken. Several improvements were also made to the performance of the selected solar collectors including: the incorporation of a new selective coating to improve thermal efficiency; and use of a new laser-welding process to facilitate production line manufacture. To achieve sufficient performance from the lithium-bromide and water absorption heat pump, it

C8 Solar collector prototype

is essential that the solar collectors supply water at relatively high temperatures, of approximately 80°C. Thus they need to be of an efficient design, but should not be too expensive. Two types of solar collector were assessed: evacuated-tube collector arrays and efficient flat plate collectors.

The Absorption Heat Pump

In order to use solar thermal energy to cool buildings, a heat pump may be interposed between a heat source and a cooled surface - in this case between the solar collectors and the embedded-pipe floor-cooling array. Measurements of the operational efficiency of the absorption heat pump (AHP) in response to changes in several key parameters were undertaken including the temperature of the water from the solar collectors, from the cooling floor and from the cooling tower. Prototype testing of the absorption coupled to the solar collectors and a cooling floor took place under real conditions. A coefficient of performance (COP) of 0.7 was achieved in early tests. Lithium-bromide and water were chosen for use with the absorption heat pump in preference to ammonia and water used in other systems. The use of ammonia has environmental disadvantages and the necessary operating temperatures are considerably higher than with a lithium-bromide and water system. Some lithium-bromide and water AHP systems are available on the market, mainly from manufacturers in the USA and Japan. The SOLHEATCOOL project has aimed to demonstrate this technology under European conditions where, as yet, no manufacturer of such systems exists.

The Heating / Cooling Floor System

Radiant floor heat distribution systems are well suited to use with solar thermal collectors due to the relatively low operating temperature of the working fluid. While radiant floor heating systems are now commonplace, floor cooling technologies and systems are relatively new and no standards for their design are yet available. This project has sought to use radiant floors for both heating and cooling using fluid temperatures of 12 – 20°C, compared with fluid temperatures of 7 – 12°C used in conventional air conditioning systems.

The study of the heating / cooling floor system involved measurement of the heat exchange coefficient, sizing of the whole system and analysis of operation in response to control system inputs.

The Control System

The correct programming and operation of the control system are of crucial importance in allowing the system to operate at maximum efficiency, especially in cooling mode, and to ensure that condensation problems at the floor are avoided. The control system's response was tested using 'pseudo steps' in supply water temperature. The floor system was also tested in response to several operational scenarios including: a slow, mean and rapid increase in the external dew point temperature; a rapid increase in the load, and a cycle involving internal inputs and solar load simulation.

The results indicate that the control system should be capable of ensuring a rapid water temperature response to variations in the external dew point temperature in order to limit the risk of condensation at the surface of the floor.

Conclusion

A handbook has been prepared that describes the research work, the system modelling and the performance of the final system, and includes data obtained during system and component testing.

This handbook is available from COSTIC (e.michel@costic.com).

Market Potential

There is considerable market potential for import substitution and for export to world markets. Some lithium-bromide and water AHP systems are available at present, mainly from manufacturers in the USA and Japan.

The SOLHEATCOOL project has aimed to demonstrate this technology under European conditions where, as yet, no manufacturer of such systems exists.

Absorption heat pump