EXPERIMENTAL ASSESSMENT OF A SOLAR COOLING SYSTEM FOR ICE PRODUCTION

INSTITUTO DE ENERGÍAS RENOVABLES

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4th International Conference on "Energy, Sustainability and Climate Change"

ESCC 2017
Table of Contents:

- Motivation
- Objective
- Compresion Systems
- Absorption Systems
- Designing of the absorption cooling system
- Results
- Conclusions
Objetive:

Development of an absorption cooling system with a capacity of 8 kg/day of ice production using exclusively solar energy as the heat source.

Secondary objectives:

- Development of a CPC to concentrate the solar radiation to produce the refrigerant.
- Determination of the working mixture to be used in the system.
- Development of the absorption cooling system.
Compression cooling cycle

![Diagram of a compression cooling cycle]
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Compression and absorption cooling cycles

Mechanical Compressor

Condenser

Evaporator

High pressure
Low pressure

EV

Compressor

Thermal Compressor

Condenser

Generator

Evaporator

Absorber

Solution with low concentration in R
Solution with high concentration in R

Refrigerant (R)

Refrigerant (R)
Absorption cooling system

- Evaporator
- Absorber
- Condenser
- Generator

Pressure levels:
- Low pressure: $P_E$, $P_A$
- High pressure: $P_C$, $P_G$

Temperatures:
- $T_E$
- $T_{C}$, $T_A$
- $T_G$

Heat flows:
- $Q_E$
- $Q_A$
- $Q_G$
- $W_P$

Solution: HEₙ Solution
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Intermittent absorption cooling system

- Generator Absorber
- Condenser
- Evaporator

Pressure and temperature relationships:
- High pressure:
  - $P_C$ (Condenser pressure)
  - $P_E$ (Evaporator pressure)
- Low pressure:
  - $T_E$ (Evaporator temperature)
  - $T_C$ (Condenser temperature)
  - $T_G$ (Generator Absorber temperature)

Heat flows:
- $Q_C$ (Condenser heat)
- $Q_G$ (Generator heat)
- $Q_A$ (Absorber heat)
- $Q_E$ (Evaporator heat)
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Conceptual system diagram
Ray tracing at different incidence angles on the CPC
Schematic diagram of the system
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First prototype
Final prototype
Main equations

Ammount of ammonia produced:

\[ m = \rho v \]

Energy received by the CPC:

\[ Q_R = \sum_{i=1}^{n} H_i tA \]

Cooling power:

\[ Q_{EV} = m_{H2O} (C_p \Delta T + h_f) \]

Coefficient of performance:

\[ COP_S = \frac{Q_{EV}}{Q_R} \]
Temperatures profile of the system
Internal view of the first evaporator and ice produced
Modelling of the cylindrical evaporator on CFD
Modelling of the cylindrical evaporator on CFD
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Ice produced in the cylindrical evaporator No. 1
Ice produced in the cylindrical evaporator No. 2
Ice produced in the cylindrical evaporator No. 2
SISTEMAS DE ENFRIAMIENTO OPERADOS CON ENERGÍA SOLAR

Generator pressures
Ammonia produced by the system
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Solar coefficients of performance
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! Thanks for your attention !