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Quality level assessment of sorption chillers installed in solar cooling plants

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Abstract

The use of reliable, representative and reproducible data for the assessment of the quality level of HVAC systems and components on seasonal basis is crucial especially in view of the obligation of energy labelling, which is due by September 2015, and of the market surveillance.

An analysis on the current normative framework dedicated to sorption chiller has revealed that no exhaustive references for sorption technologies and applications exist. Therefore, two test procedures aimed at the mapping of performances of sorption chillers at full and part load have been developed. The procedures developed take into account also different machines operating modes (i.e. continuous and discontinuous). A first attempt of validation of the test procedures has been carried out and here presented.

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1. Introduction

In the last years, the European commission has pushed the selling of high-energy efficient products by issuing directives (*Eco-design and Eco-label Directives* [1], [2]) prescribing the minimum energy efficiency requirements for class of products as well as the indications for their labelling [3]. This has induced stakeholders (sector industry) and private organizations to develop, in parallel, voluntary third-party certification schemes with the aim of demonstrating that a specific product not only conforms to the relevant dedicate European standard, but fulfills further and more restrictive quality requirements. This has occurred especially in those sectors, like the HVAC

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sector, where the necessity to accelerate the standardization process and to make a sort of market surveillance through the affixing of certified energy labels was more pressing [4].

Also the solar thermal industry has developed its own certification scheme, the Solar Keymark [5], with the intent of reducing the trade barriers by promoting the use of high quality solar thermal products and to overcome normative lacks becoming an authoritative mark proving the energy consumption levels.

Within this context, the use of reliable, representative and reproducible performance data for the assessment, on seasonal basis, of the quality level of solar systems and components as well as the definition of the procedures to obtain them, play a crucial role.

An analysis on the current normative framework dedicated to solar cooling systems and, in particular, to sorption chillers, has revealed that, even if this technology has reached in the last years an increased level of development both in terms of components and of control strategies - new chillers, specifically intended for small-sized and medium-sized systems, have been commercialised as well as solar "kits" [6] -, no exhaustive and coherent references for their assessment exist. Therefore, the definition of a reference standard for sorption chillers is needed.

With this regard, in the subtask A1 of the project Task 48 [7], "*Quality Assurance & Support Measures for Solar Cooling*", promoted by IEA-SHC, two test procedures aimed at the "mapping" of the chiller performances at full load and at partial load and able to provide specific provisions on the basis of their operation (i.e. continuous and discontinuous) have been developed. The main expected result is to provide reliable data to be used as input for calculation methods for the seasonal performance evaluation of the chillers, like the BIN METHOD, or as input for the development of numerical models able to simulate their behaviour on annual basis within specific boundaries.

The present paper intends to illustrate the most relevant parts of the developed procedures and to present the results obtained from the first attempts of their validation.

Nomenclature

Continuous operation	Chiller's operation in which the four phases (i.e. desorption, condensation, evaporation, absorption) are processed continuously
Discontinuous operation	Chiller's operation in which the four phases (i.e. desorption, condensation, evaporation, absorption) are periodically shift among the internal components generating a cyclic functioning
Calculation cycle	Period between four consecutive swaps, i.e. shifts of the four (or couple of) phase among the internal components
EER_{th}	Thermal Energy Efficiency Ratio [kW/kW]
EER_{el}	Electrical Energy Efficiency Ratio [kW/kW]
T_in_GEN/ T_ GEN	Inlet temperature at the generator [°C]
T_out_GEN	Outlet temperature at the generator [°C]
T_in_COND/ Tcond/abs	Inlet temperature at the condenser/absorber [°C]
T_in_EVA	Inlet temperature at the evaporator [°C]
T_out_EVA	Outlet temperature at the evaporator [°C]
Flow_GEN	Flow rate at the generator [m^3/h]
AVG_Flow_GEN	Average of the generator's flow rate over the test period [m^3/h]
Criteria_STDEV_ Flow_GEN	Criteria for establishing the machine's stationary expressed in terms of permissible standard deviation of the generator's flow rate over the test period [m^3/h]
STDEV_ Flow_GEN	Standard deviation of the generator's flow rate over the test period [m^3/h]

2. Approach

For the drafting of the two test procedures, a preliminary study on the existing testing protocols having in the "scope" the procedures for the performance assessment of sorption chillers or appliances belonging to the same class of products (e.g. gas fired and electrically driven chillers and heat pumps) has been carried out. Such study has