DEVELOPMENT OF A SOLAR WATER HEATERS EFFICIENCY TEST FACILITY IN URUGUAY UNDER ISO STANDARDS

Summary

The local development of a solar water heaters efficiency test facility under international standards is presented. The platform is based on a pre-existing design (CENER laboratory) that was locally adapted, and is capable of testing solar collectors under ISO 9806:2013 standard and solar systems under ISO 9459-2 and ISO 9459-5 standards. The first locally obtained solar collector efficiency curve is derived, which is a first milestone for the platform. This facility is intended to test these equipments for Uruguay's market and also to serve as a high-level laboratory for solar thermal research.

Keywords: Solar collectors, solar heating systems, test facility, ISO standards.

1. Introduction

In the last 10 years Uruguay has done deep changes in the way that the country generates and uses its energy. This change was mostly driven by a high incorporation of non-conventional renewable energy sources on a countrywide scale. Several large scale grid-connected wind and solar projects are currently operational, which has led to an almost 100% renewable electricity sector. On the energy demand side, there has been other efforts aiming to improve energy efficiency. In 2009, a law that estates that the research, development and training in solar thermal energy is of national interest was approved, and also it establishes that new constructions of hospitals, sport clubs and hotels will only be authorized if at least 50% of their water heating demand is supplied by thermal solar energy. The development of local solar water heaters test facilities was required in order to test the quality and efficiency of the imported and local-manufactured equipments. These capacities were funded by the national Ministry of Industry, Energy and Mining (MIEM, Uruguay), with the objective of controlling the equipment's characteristics sold in the local market, promoting the national manufacturers and developing local human capital in the field. In this work, the local development of an efficiency test facility for solar collectors and systems is presented, which complies with the ISO 9806:2013, ISO 9459-2:1997 and ISO 9459-5:2007 international standards.

2. Local development

The development of solar water heaters efficiency test facilities poses a challenge due to the high degree of precision required by international standards, mostly regarding temperature and flow rate measurement accuracy, control and stability. Rather than purchasing a turn-key solution for test facility, a hybrid development strategy was used, where a pre-existing design was adapted to the local equipments availability and constrains. The base design was obtained through a consultancy service provided by CENER. The local design consist of two separated lines for outdoor testing Solar Water Heating (SWH) collectors and systems, as shown in Fig. 1. The two set-ups for collector testing are on the sides and the two set-ups for systems testing are in the middle. In the back (at the South), there are two containers where the thermo-hydraulic installation and the control system are allocated. In this facility it is possible to test solar collectors from 1 m2 to 5 m2 with an inlet temperature up to 90 ºC. In order to maximize the time in where the steady state solar irradiance condition is met, the collectors testing set-ups are provided with solar trackers. This allows, for instance, to complete a solar collector test in one clear-sky day. Systems set-ups are designed to test equipments up to 600 litres tank capacity, including daily system performance test, mixing degree determination and storage tank heat losses for the ISO 9459-2 standard and the dynamic system testing of the ISO 9459-5 standard. First class pyranometers according to the ISO:9060:1990 standard are used for global tilted and diffuse irradiance measurements. Ventilation units are included to obtain a controlled wind velocity over the collectors as required in the standards. The heating for both set-ups is done with a dedicated electric storage water heater, but for systems testing also a gas heating stage is used. For cooling, a centralized chiller and cold water tank is used. The required high accurate temperature setting is achieved by controlling the flow rate in the heat exchangers. The control system is based on a Siemens PLC S7 1200

from where it is possible to set all the facility's parameters, including temperature and flow rate set-points and open/close valves. This last January the first complete solar collector efficiency test under the ISO 9806:2013 standard was performed. This allow us to derive the first efficiency curve obtained from a local test, which is shown in Fig. 2. At this moment, we are working in the control programming for systems testing, which is expected to be ready in the next month.

Fig. 1: Solar Water Heaters test facility installed in Uruguay.

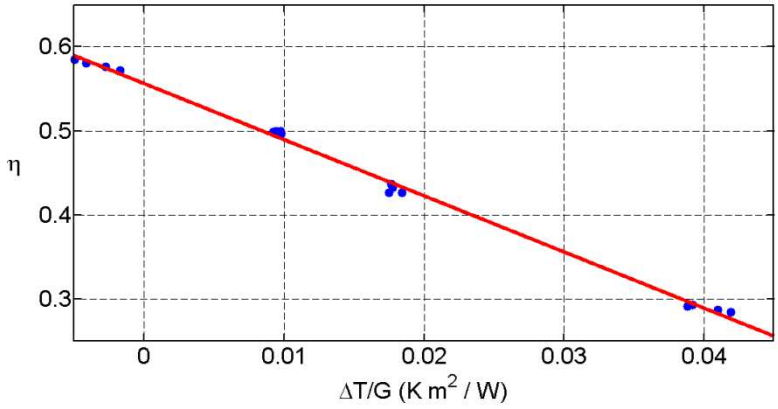

Fig. 2: First solar collector efficiency curve derived in Uruguay under ISO standards.

3. Conclusions

We describe the local development of a SWH test facility in Uruguay. It accomplish the objective of being inexpensive (an overall cost of half a million dollar, including base infrastructure construction) while being effective in training local human capital in SWH testing. It allowed to obtain the first solar collector efficiency curve that was entirely derived in the country under ISO standards, which is presented. This experimental facility will be also a high-level research platform in where, for example, non-steady state solar collector test may be performed.

4. References

ISO 9806:2013. Solar energy -- Solar thermal collectors -- Test methods.

ISO 9459-2:1995. Solar heating - Domestic water heating systems - Part 2: Outdoor test methods for system performance characterization and yearly performance prediction of solar-only systems.

ISO 9459-5:2007. Solar heating - Domestic water heating systems - Part 5: System performance characterization by means of whole-system tests and computer simulation.

ISO 9060:1990. Solar energy -- Specification and classification of instruments for measuring hemispherical solar and direct solar radiation.