Standards for Collectors and Components in the pipeline

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INTRODUCTION

The European Commission has in the White Paper (1997) set the target at 12 % of energy to come from renewable energy sources by 2010, which implies that an increased use of solar thermal systems will be an important contribution. In order to get a wide spreading of solar thermal products with an open European market it is necessary to have harmonised standards for testing and mutual accepted certification procedures. Therefore, a common EU quality label for solar thermal products was established in 2003 (Nielsen, 2003). The mark is a CEN/CENELEC Mark which is called “Solar Keymark” and it is based on testing according to the EN standards for solar collectors (EN 12975) that were introduced in the same period (Wahlström, 2003). (Later on Solar Keymark was also established for solar thermal systems based on the standard EN 12976.) With harmonized standards the goal to establish a fair market for testing can be reached which implies that several laboratories are accredited and experienced in performing the tests. A quality label accepted in most of Europe will give a large market access which will make it possible to avoid expensive and/or low quality products that would eliminate the market for all solar thermal products.

Even though the standard for solar collectors (EN 12975) is established it is not yet universal and there are still some conflicts remaining between the standard and national regulations or requirements. To solve the conflicts and break down the barriers for an open market the standard still need to be developed and specified in certain tasks. At the same time new products are introduced at the market which also involves standard development.

APPROACH

One part of the ongoing Intelligent Energy Europe project Solar Keymark II is to coordinate, develop and agree on procedures for development of the EN 12975 standard. The objective is to provide inputs to ongoing and future work of standardisation group CEN TC 312 “Thermal solar systems and components”, which do revisions of solar thermal standards. The work has its focus pointed either at the EN 12975 standard or on new standards to be developed covering related products or sub components. In this respect, the input can be divided in three categories:

1. direct proposals for revisions of EN 12975,

2. “resource documents” either to be referenced in EN 12975 as a support to its interpretation and practice, or to be used as drafts for future standards,

3. proposals that indicates that further work are needed.

The work is partly based on a questionnaire made in 2004 that was addressed to industries and research institutes in Europe. It was answered by 7 representatives from the solar thermal industry and by 10 research representatives. Furthermore, it was answered at a work shop in November 2004 arranged by ESTIF (European Solar Thermal Industry Federation) with approximate 25 industrial companies represented. In the questionnaire the respondents were asked to give priority to and comment on different potential working areas within this field.

The results from the questionnaire revealed a particular interest in improved exposure tests for collectors, m^2 to energy conversion, improved characterization of incidence angle dependencies, methods for accelerated testing and determination of optical properties for absorber- and reflector materials. Some of items above has been further developed within the European project NEGST (New Generation of Solar Thermal Systems) and thereafter passed on as recommendations to TC CEN 312 (Kovács et al., 2007). As the solar energy field is growing rapidly at present, the conditions and requirements for standardisation are also quickly changing. It is therefore reasonable to assume that some of the products and techniques that were of no interest yesterday will be on top of the list tomorrow. Within the Solar Keymark II project the following topics for improving EN 12975 is considered:

- annual collector energy output,
- performance and quality tests for collectors with evacuated tubes,
- collector components - requirements and test methods,
- improved exposure - accelerated ageing test of collectors.

ANNUAL COLLECTOR ENERGY OUTPUT

The most important function of a solar collector is its energy performance, the energy output during one year. Based on results from testing according to EN 12975 it is possible to calculate an annual energy output. However, the energy output might differ depending on which test laboratories that performs the calculations due to different calculation procedures. Furthermore the energy output will be dependent on where the solar collector will be located and used in

practice, i.e. the outdoor climate, the tilt angle and the collector mean temperature. In order to be able compare different kinds of solar collectors from test result, independent of which test laboratory that has performed the test and where the collector finally will be located, it is important to have a standard procedure on how to calculate an comparable energy output.

A standardised procedure for calculation of the annual collector energy output based on the performance parameters resulting from efficiency tests according to EN 12975 and reference climates is now under development in the Solar Keymark II project. The procedure is programmed into an Excel spread sheet that will be available for all test laboratories and is meant to be an informative annex to EN 12975 in the future. The aim is that it should be easy to perform the calculations while still giving enough sophisticated results that can consider specific features of the most common collectors in the market, it will mainly facilitate performance comparisons for potential buyers.
The Excel spread sheet procedure is based on hour by hour calculation with the input of performance parameters resulting from an efficiency test to calculate the incident angel modifier. Other predefined inputs that should be chosen are the collector inlet temperature (25, 50 or 75 ºC), location (Athens, Davos, Stockholm and Wurtsburg) and tilt angels (0, 30, 45, 60 and 90 degrees). An example of results with the Excel spread sheet is given in Fig. 1.

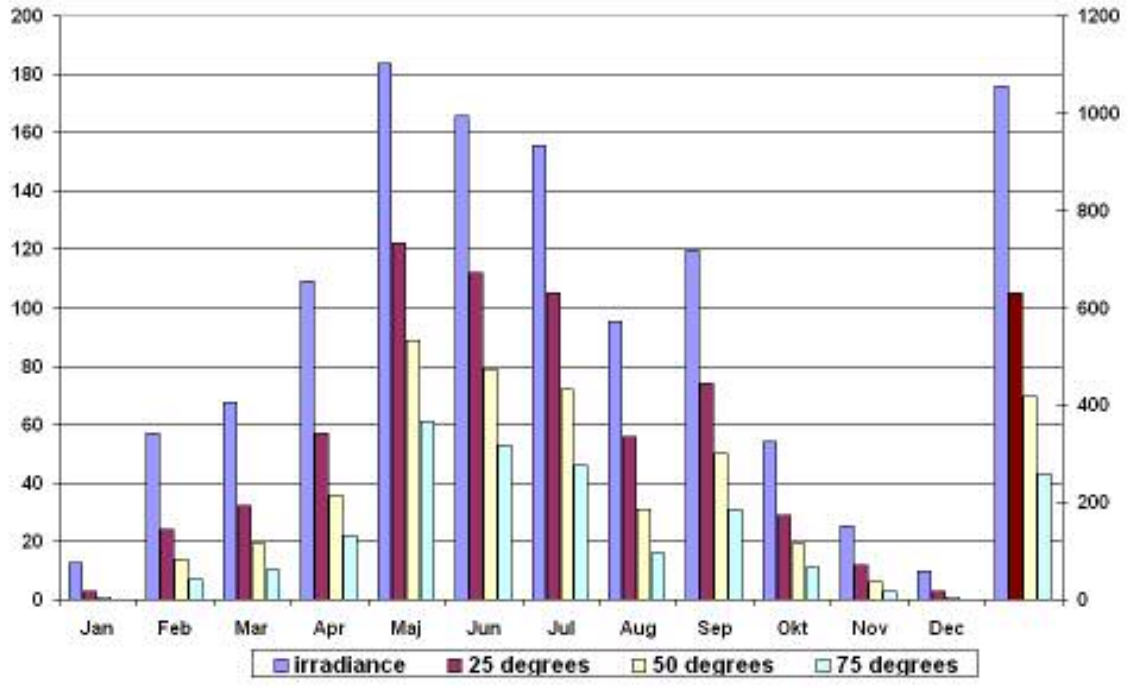

Fig.1. Example of results for monthly and annual energy output for different inlet temperatures calculated with a developed Excel spreadsheet. The left y-axis has the unit kWh per m^2 and month and right kWh per m^2 and year.

PERFORMANCE AND QUALITY TESTS FOR COLLECTORS WITH EVACUATED TUBES

Most of the work related to development of test methods and quality criteria for solar collectors has been done mainly by considering plate collectors. Only to a minor extent has evacuated tubular collector (ETC) and its specific properties been addressed. ETC collectors today have a remarkable development of the Chinese solar thermal market. In ten years their market shares have grown from 35 to 85 %. The total annual sales of collectors are around 15 million m^2 and growing by an annual 30%. In Europe ETCs have not been the same success so far but their shares are increasing and they have a significantly potential to contribute to a large scale introduction of solar thermal products. In order to meet this market development it is necessary that testing of performance and quality should also take the specific characteristics of ETCs into account. This is considered in the Solar Keymark II project that is developing procedures for quality and performance testing of ETCs.

The work is based on a questionnaire about ETC testing performed in 2005 among 15 test laboratories, a few manufacturers and importers (Kovács et al., 2007). The purpose of the inquiry was to give a background to an assessment of the need for revised test procedures regarding performance- and quality testing of ETCs. The questionnaire turned out to raise a number of new questions and the ongoing work is based on some of the proposals that were addressed:

- ETCs have comparatively low heat losses which results in higher stagnation- and maximum operation temperatures than compared to flat plate collectors. This means a higher probability for fault to occur during the high temperature- and exposure test that might affect the collector's efficiency. In order to reveal low quality products it is recommended to introduce a test cycle for these collectors. First the collector is measured for efficiency, then to a high temperature- and exposure test and finally for efficiency once again. In order to save costs one of the efficiency tests could be limited to zero loss efficiency, but preferably also the eventual increase in heat losses should be assessed. In order to get knowledge about the affect of introducing a test cycle measurements are ongoing with the test cycle for two types of ETCs.

- Damaging of heatpipes due to freezing can result from improper composition of the working media in the heatpipe or from bad design of the metal tube (material quality, thickness, shape of lower end) and has been reported by several sources (Kovács et al., 2007). As breakage of the metal tube in the case of bad design often doesn't occur until after several freeze cycles, a new procedure for freeze testing has been proposed and will be tested and evaluated within the Solar Keymark II project.

- The EN 12975 standard has today weaknesses of not describing in detail where the stagnation temperature should be measured and with higher stagnation temperatures it will be difficult to determine unambiguous

stagnation temperature. Special attention is also required in order to avoid thermal stress on the heat transfer fluid. These problems will be more obvious for ETCs and an investigation is ongoing in the Solar Keymark II project where the stagnation temperatures are measured at different places of the ETC.

- The EN 12975 standard has today weaknesses of difficulties to determine efficiency at high temperatures with good accuracy which will be more obvious for ETCs since they have high operation temperatures. Several laboratories have reported that dry out effects can occur during testing of ETCs with heat pipes during high irradiance conditions and that the present collector model used in the standard was not able to accurately model the thermal capacitance and time constants of the collector. The method available for calculating the thermal capacity of the collector has been reported to underestimate the figures for double glass ETCs. These are also important subject for further research that is needed in near future.

COLLECTOR COMPONENTS - REQUIREMENTS AND TEST METHODS

Durability testing of solar absorber coatings, anti reflective coatings, reflector materials and polymer components of solar collectors were early addressed as important subjects for improvement of standards and they have already been accepted as part of upcoming revisions of EN 12975 by the CEN TC 312 meeting in Canary Islands in April 2006.

- The absorber itself, in the collector, is directly or indirectly subjected to a number of tests in the present standard for collector testing EN 12975. Requirements for reliability are also defined. However, for the long term durability of the absorber or more specifically, the absorber coating, there are no requirements. Considering the rapid and continuously ongoing development of new materials, coatings etc. and the increasing specialization among manufacturers, it is assumed that manufacturers of absorbers could benefit from methods that can ”predict” a long service life. Standardised methods and requirements would also benefit their clients, the collector manufacturers, who would then be able to strengthen quality requirements on their suppliers. A new document: “Recommended qualification test procedure for absorber surface durability” (Carlsson, 2004) describes tests applicable to organic and inorganic coatings can more or less be considered ready for inclusion in the standard.

- Polymer materials have so far only been used to a limited extent in solar thermal applications. In low temperature applications such as pool heating the introduction has been very successful and in general without problems related to the materials. On the contrary, in medium and high temperature applications where polymers were tried to replace inorganic materials, it has in general failed. As polymers definitely have many potential advantages to offer

in solar thermal applications compared to traditional materials, it will be useful to researchers and manufacturers to have a set of common tools and methods to assess their properties and suitability for more demanding applications. The work to include these considerations into the standard is still within the starting phase but there are some methods that can provide an extensive input to this field.

- Another subject for improvements of standards is the increasing use of reflectors and anti reflective coatings of cover materials as a cost efficient way of improving the performance. It is a highly exposed component having a high influence on the performance, but is not assessed in the present standard. For example it is a need to be bale to assess the long term effects on the collector output. At present no standardised methods are available for this purpose.

IMPROVED EXPOSURE - ACCELERATED AGEING TEST OF COLLECTORS

The present European exposure test has been under a lot of debate, mainly due to its inability to maintain uniform test conditions when applied in different parts of Europe. Furthermore it is not considered to reveal the weaknesses of ETCs. Some countries have since long had stricter exposure tests than what is required by EN 12975, and one of the main objectives in the Solar Keymark II project is to eliminate such barriers. Two different methods are now evaluated within the Solar Keymark II project as new candidates for exposure test, but it is not yet clear if any of them will be sufficient enough. The test needs to have the following requirements:

- solve the basic problem of irreproducible test conditions in different locations,
- the tests should not be unnecessarily long lasting since it will take to long time to come out with new products and it will give expensive testing.

CONCLUSION

Only with a common accepted European mark of high quality solar thermal products will it be possible to avoid low quality products that could eliminate the market for all solar thermal products. Solar Keymark is based on testing according to good, operational and generally accepted European standards and several test laboratories are accredited to perform the tests. This is the basis for a fair market for testing and at the same time is testing in one country accepted within other parts of Europe. This will give reasonable costs for the manufactures to test their products.

As the solar energy field is growing rapidly at present it is important to continuously meet the changed conditions and requirements with improvements of the standardised test methods. With the work presented in this paper it is

clearly that it is important to continuously make questionnaires to industry and research within the field to observe need for improvements and to take actions for developments.

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