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# Solar thermal collectors outdoor testing in saline environment

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**Abstract**

For assessing the efficiency, performance and/or durability of flat plate solar thermal collectors, an accelerated outdoor aging test is proposed, based on salt spraying. The flat plate collector is tested using air as working fluid and without circulation. A testing methodology is proposed along with three evaluation criteria, based on the temperature at the collector's outlet and on the outdoor temperature. The ratio of these two temperatures is found to be relevant in outlining the changes resulted due to accelerated aging of the collector, most likely of the sealing, when micro-cracks allow the fine aerosol droplets to penetrate inside the collector, at outdoor temperatures above 25°C. The results need inter-laboratory validation and can represent a step forward in defining a novel quality standard.


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*Keywords:* solar thermal flat plate collector; aging; saline environment; testing stand;

## 1. Introduction

There are currently many producers and users of solar thermal systems and solar collectors with quite different performances, all over the world. To assess the quality of any collector, internationally recognized threshold values of certain properties are required, along with a unitary methodology for quality certification, and now-a-days there are many national standardized procedures developed and implemented all over the world; this represents a good start but, since the procedures are not unitary, their comparison can be rather difficult (or even impossible), thus leaving room in the market to a significant amount of fakes; therefore, there is a worldwide interested to achieve and

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promote standardized global certification [1,2] that should support quality developments at manufacturers level and quality assurance for the users.

Since almost 20 years, solar collectors that work at low to medium temperatures are tested to evaluate the thermal performance in static and quasi-dynamic conditions, along with their durability and resistance as quality indicators. The main durability and resistance tests for solar collectors are [2,3]: internal pressure tests for absorbers; high-temperature resistance test; exposure test; external thermal shock test; internal thermal shock test for liquid-heating collectors; rain penetration test; freezing test and impact resistance test (optional). A draft of a common international standard for solar thermal collectors testing was recently developed as result of the co-work within IEA-SHC Task 43, Solar Keymark Network, SRCC, ISO/TC180 and CEN/TC312, [4], including air heating collectors, PVT collectors, tracked and concentrated collectors; specific focus is set on durability and performance of evacuated tubes, durability and performance of heat pipes for evacuated tubes, durability of absorber surfaces, characterization of glazing, characterization of insulation. This focus is well justified by a large amount of research tests developed for the components of the flat plate collectors, particularly for the absorber plate and glazing, [4,5]. Accelerated aging tests are proposed both in indoor conditions (mainly climatic chamber) but are also reported in outdoor environment, [4,6,7].

One particular aspect might need more attention and this is related to the collectors that are operating on seashore areas. The implementation of small/residential solar-thermal systems is largely spread and preferred locations are in warm areas, particularly on the seashore, in summer resorts. Here, flat plate collectors are mainly used for the preparation of domestic hot water and their technical and market competitiveness is determined by the economic factors (initial and operation costs, interest rates, payback time), their efficiency, and, last but not least, their lifetime. Operating in a seashore area has several particularities given by the salty environment in the atmosphere which contains fine aerosols of seawater in air, produced by the constant breeze. The effect of salty environment on metals corrosion is well known and can affect the metal casing, and corrosion tests are already existent (e.g. ASTM B 117 and ISO 9227 salt spray corrosion resistance test of coated samples); these could be easily translated to solar-thermal collectors. Also salt spraying is reported as testing procedure of the reflecting layer for solar thermal facades in the standard SO/CD21207 method A, [8].

Another effect of combined heat and salty aerosols could be expected on the sealing and, to the best of our knowledge, there are no reports on tests regarding the tightness of low-temperature or medium -temperature thermal collectors. The tightness of a flat plate solar collector is good but not at the level of a PV module, and the seals – subjected to quite large temperature variations, are usually less resistant as compared to the usual lifetime of a collector (20…25 years). The results is that water vapours or very small liquid droplets can enter inside the collector and, during night, will promote condensation on the inner side of the glazing and on the absorber plate; when implemented in the seaside areas, the salty aerosol atmosphere is also likely to penetrate inside the collector and – condensed - will affect the glazing (inorganic or organic glass) but will mainly affect the absorber plate, inducing erosion/corrosion of the spectral selective coating, thus reducing the conversion efficiency due to fast aging.

Lately this problem was approached in an analysis on glazing aging, developed in six different implementation sites, including one maritime site, [6]. Although responsible for the fast degradation of their performances, aging tests in saline environments are not standardized yet for the collectors.

This paper presents the preliminary results on outdoor testing of a solar thermal flat plate collector under “salt spray”, developed as a saline aerosol. A testing methodology is proposed and there are analysed relevant parameters that can be used as criteria in appreciating the durability of the entire collector.

## 2. Testing infrastructure and methodology

### *2.1. The testing infrastructure*

Experimental test were performed on the rig implemented on the rooftop of the laboratory building of the R&D Centre Renewable Energy Systems and Recycling, in the Research Institute of the Transilvania University of Brasov (latitude 45°66’ N, longitude 25°61’, 600m above the sea level, with a continental temperate climatic profile).

The weather data were monitored and registered (each 10 min) using a Delta T weather station, with an ES2 energy meter (for global and diffuse radiation, ±3% accuracy) and with temperature, wind speed and direction, and atmospheric humidity sensors.