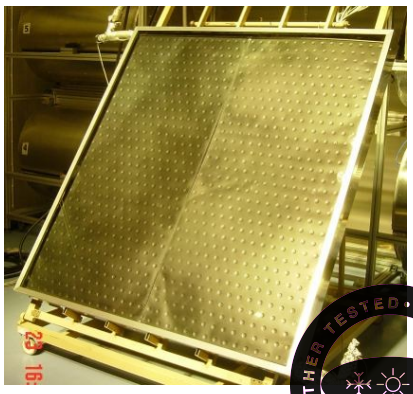
Tellus Functional Solar Test

Customer:

lamit.fi
Kellosepänkatu 21
FI-44200 Suolahti

Target:



Solar collector made by lamit.fi

Gross dimensions: 1.57x1.68 m^2
Aperture dimensions: 1.495x1.62 m^2

Front glass: 4 mm thick low iron glass

Testing time:

23rd of May, 2011

The Purpose of the Test:

Measurement of the efficiency of the solar collector at the volume flow rate of 4.0 l/min.

Test Method:

Solar Radiation: > 800 W/m^2
Flow medium: water
Flow rate: 4 l/min (100 kg/m^2/h)
Simulated wind: 0 m/s

Four different inlet temperature values with two to three measurements at each point in steady state conditions to determine the equation of the efficiency.

The absorber area of the solar collector was used in calculating the efficiency. The test method is based on the standards ASHRAE 93-77 and EN 12975-2.

Validation of test method:

ASHRAE 93-77 and EN 12975-2 are a suitable methods to measure the efficiency of solar collectors in various conditions. The effect of the flow rate to collector efficiency is made by measuring the efficiency curves of the solar collector at the given range of flow. The function of the efficiency curve is fitted using all relevant measurement points.

Performed actions:

Simulated radiation

The solar radiation was simulated with many metal halide lamps. This type of lamp is widely used to simulate solar radiation. The spectrum of the solar simulator and the AM2 spectrum in the wavelength range of 300 – 800 nm are in the figure. There are some characteristic peaks in the spectrum of the simulator lamps. These peaks have no significant effect in solar thermal testing.

On the right there is a figure of the energy distribution of the solar simulator.

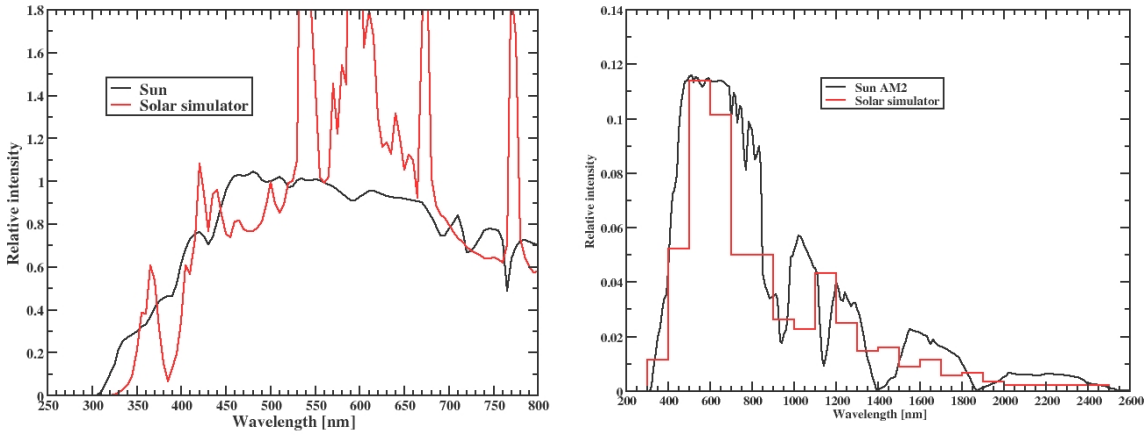


Table 1. The amounts of solar radiation, the radiation from the solar simulator and the allowed tolerances in the ranges of ultraviolet (UV), visible radiation and thermal radiation (IR). Total radiation 870 W/m^2

	UV [W/m^2]	Visible [W/m^2]	IR [W/m^2]
Sun	54	435	381
Solar simulator	50	465	355
Allowed tolerances e.g. according to IEC 68-2-5 (1975)	± 30%	± 10%	± 20%

To control the long way IR-radiation incident to the solar collector the distance between solar simulator and solar collector was in this test 4.5 m.

Efficiency measurement at the volume flow of 100 kg/m²/h

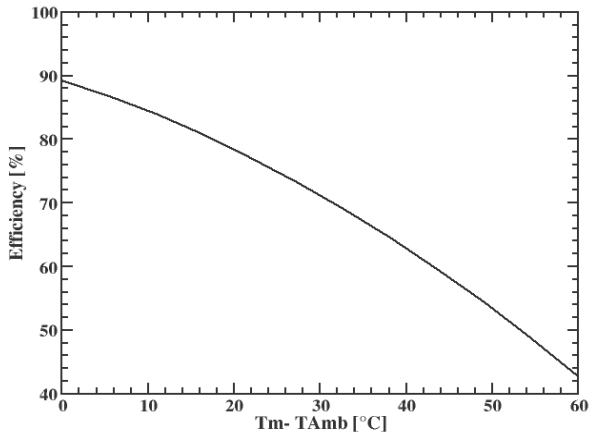
The mean over pressure during the efficiency test in the absorber pipes was calculated to be 30 kPa. The tilt angle of the solar collector was 55°. The aperture area of the solar collector used in the efficiency calculations was 1.495x1.62 m² which is 2.42 m². The incident perpendicular radiation intensity E onto the solar collector was measured from a 7x7 matrice to be 870 ± 90 W/m².

The efficiency of the solar collector was measured at four measurement points when there was no wind. The stability of the measurement point was checked by a five minute loop during which the inlet and outlet temperatures in the solar collector should stay stable.

The density and specific heat of water (R and Cp), volume flow V [l/min], inlet, outlet and ambient temperatures and calculated temperature differences and efficiencies are tabulated. The efficiency measurements were made in the order: ΔT=-4°C, ΔT=53°C, ΔT=35°C and ΔT=15°C. There was no wind over the front glass of the collector.

R	Cp	V	Tin	Tout	Tamb	Tout-Tin	Tm-Tamb	(Tm-Tamb)/E	η
0.9968	4181	3.92	22.04	29.06	29.82	7.02	-4.27	-0.0049	90.8
0.9969	4181	3.88	21.63	28.74	29.51	7.11	-4.32	-0.0050	91.1
0.9970	4181	3.91	21.36	28.49	29.50	7.13	-4.57	-0.0053	92.0
0.9707	4200	4.04	80.05	83.83	28.22	3.78	53.72	0.0617	49.3
0.9707	4200	4.04	80.04	83.87	28.13	3.83	53.83	0.0619	49.9
0.9708	4200	4.05	79.98	83.69	28.20	3.72	53.64	0.0617	48.6
0.9818	4187	4.08	59.99	65.15	27.66	5.16	34.91	0.0401	68.5
0.9819	4186	4.09	59.85	64.99	27.39	5.14	35.03	0.0403	68.3
0.9909	4180	4.09	40.29	46.27	27.79	5.99	15.49	0.0178	80.3
0.9909	4180	4.09	40.28	46.25	27.88	5.97	15.38	0.0177	80.0

The efficiency curve is figured. The efficiency was calculated using the absorber area of the collector.



The efficiency curve of the solar collector at the volume flow of 4.0 l/min is:

$\eta = 89.3 - 0.429(Tm - Tamb) - 0.0058(Tm - Tamb)^2$ (E=870 W/m²)

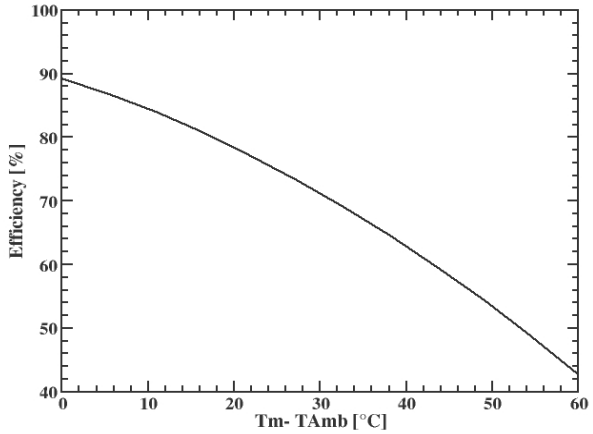
Used measuring equipment:
Solar simulator: No. 20
Solar radiation: Pyranometer No. 13, calibrated 11th of June, 2010, calibration is valid
Temperatures: AD590, calibrated 20th of May, 2011, calibration is valid

The accuracy of the efficiency measurement is ± 3 %. To the measurement accuracy affects the accuracies in the measurements of temperatures, liquid volume flow, solar radiation and the amount of measurement points.

Conclusions:

The efficiency curve of the solar collector at the volume flow of 4.0 l/min is:

$\eta = 89.3 - 0.429(T_m - T_{amb}) - 0.0058(T_m - T_{amb})^2$ (E=870 W/m^2)



Remarks:

Actions, operations and reporting are in accordance with IEC/ISO 17025 'General requirements for the competence of testing laboratories'.

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Signatures:

Littoinen, 3rd of June, 2011

Timo Oksa

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