Fraunhofer Institut
Solare Energiesysteme

Short Report: KTB Nr. 2003-31

Efficiency curve according to EN 12975-2

Brand Name:
T2

Responsible for Testing:
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Date:
11th November 2003

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1 Test Center

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3 Collector efficiency curve

3.1 Test method

Outdoor, steady state according to EN 12975-2:
Thermal solar systems and components, solar collectors, test methods

3.2 Description of the calculation

The functional dependence of the collector efficiency on the meteorological and system operation values can be represented by the following mathematical equation:

$$\eta_{(G,(t_m-t_a))} = \eta_0 - a_{1a}\frac{t_m - t_a}{G} - a_{2a}\frac{(t_m - t_a)^2}{G} \qquad (1)$$

(based on aperture area)

with: $t_m = \frac{(t_e+t_{in})}{2}$

where: G = global irradiance on the collector area (W/m^2)
t_{in} = collector inlet temperature (°C)
t_e = collector outlet temperture (°C)
t_a = ambient temperature (°C)

The coefficients η_0, a_{1a} und a_{2a} have the following meaning:

η_0: Efficiency without heat losses, which means that the mean collector fluid temperature is equal to the ambient temperature:

$$\frac{(t_{in} + t_e)}{2} = t_a$$

The coefficients a_{1a} und a_{2a} describe the heat loss of the collector. The temperature depedency of the collector heat loss is described by:

$$a_{1a} + a_{2a} * (t_m - t_a)$$

3.3 Instantaneous efficiency curve based on aperture and absorber area and mean temperature of heat transfer fluid

Boundary conditions:

Test method:	outdoor, steady state
Latitude:	48.0°
Longitude:	7.8°
Collector tilt:	tracked between 40°and 50°
Collector azimuth:	tracked

Test conditions:

Mean irradiation :	854 W/m^2
Mean wind speed:	3 m/s
Mean flow rate:	145 kg/h
Kind of fluid:	water
Period:	November 2003

G [W/m^2]	G_d/G [-]	m [kg/h]	t_{in} [°C]	t_e [°C]	$t_e - t_{in}$ [K]	t_m [°C]	t_a [°C]	$t_m - t_a$ [K]	$(t_m - t_a)/G$ [K m^2/W]	η_a [-]
922	0.08	146.5	7.39	15.76	8.37	11.57	11.98	-0.41	-0.0004	0.770
917	0.08	146.6	7.37	15.70	8.33	11.54	11.52	0.01	0.0000	0.771
914	0.08	146.6	7.36	15.64	8.28	11.50	11.65	-0.15	-0.0002	0.769
919	0.08	146.6	7.37	15.70	8.34	11.53	11.97	-0.43	-0.0005	0.770
793	0.08	143.8	34.87	41.08	6.20	37.98	11.61	26.37	0.0332	0.649
755	0.08	143.7	34.90	40.78	5.89	37.84	11.57	26.27	0.0348	0.646
732	0.08	143.7	34.90	40.54	5.65	37.72	11.42	26.30	0.0359	0.640
721	0.08	143.8	34.89	40.45	5.56	37.67	11.34	26.34	0.0365	0.639
844	0.08	144.7	62.99	67.95	4.96	65.47	9.43	56.04	0.0664	0.491
855	0.08	144.6	62.98	68.08	5.10	65.53	9.70	55.84	0.0653	0.499
871	0.08	144.6	63.00	68.29	5.28	65.64	10.10	55.55	0.0638	0.507
882	0.08	144.9	63.01	68.39	5.38	65.70	10.22	55.48	0.0629	0.511
890	0.10	144.7	91.31	95.06	3.75	93.19	8.53	84.66	0.0952	0.354
883	0.10	144.8	91.29	95.02	3.73	93.16	8.22	84.94	0.0962	0.355
879	0.10	144.6	91.31	95.05	3.73	93.18	8.79	84.39	0.0960	0.356
879	0.09	144.6	91.33	95.10	3.77	93.22	8.94	84.28	0.0959	0.360

Table 1: Data of determined efficiency points

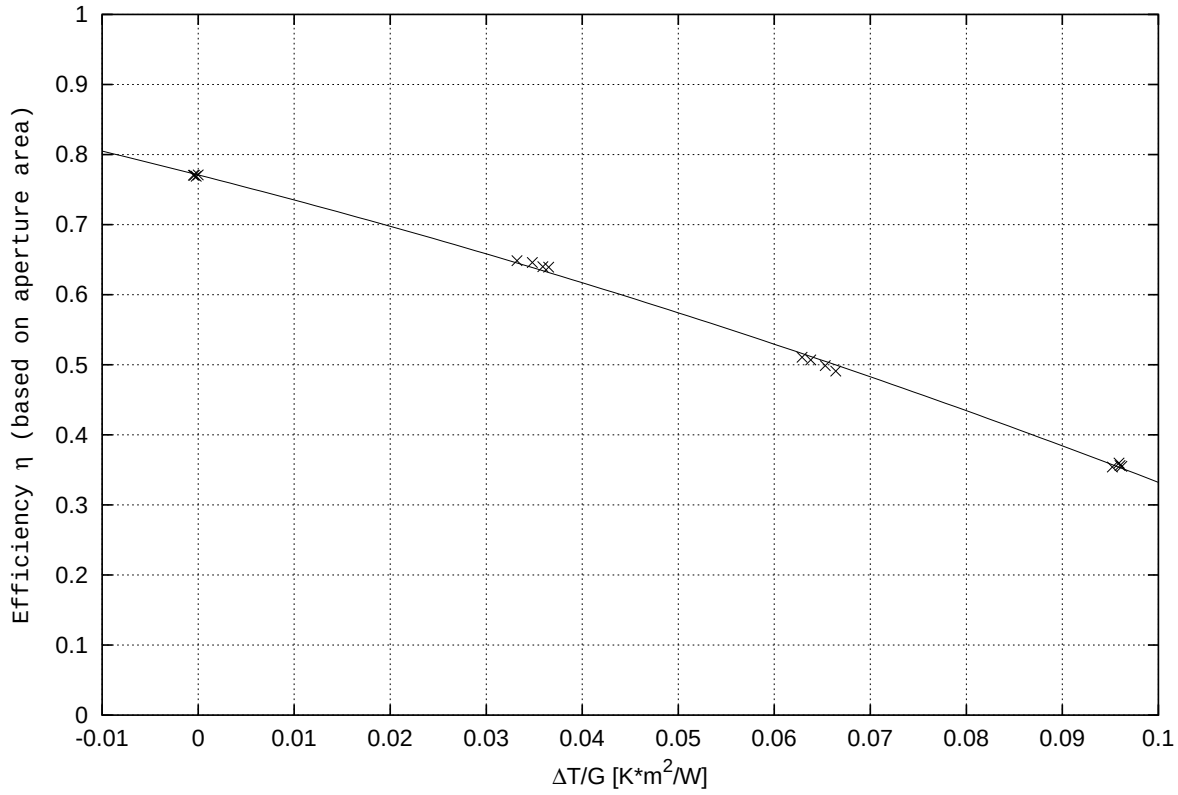

Figure 1: Efficiency curve with measurement points based on aperture area 2.013 m^2

Results based on aperture area 2.013 m^2:

η_{0a} = 0.771
a_{1a} = 3.529 W/m^2K
a_{2a} = 0.0097 W/m^2K^2

3.4 Calculation of the efficiency parameters to other reference areas

The efficiency parameters can be calculated to other reference areas according the follwoing procedure (Example absorber area A_A):

$\eta_{0A} = A_a/A_A * \eta_{0a}$
$a_{1A} = A_a/A_A * a_{1a}$
$a_{2A} = A_a/A_A * a_{2a}$

This report is not a complete report according EN-12975-2.

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Freiburg, 11th November 2003
Fraunhofer-Institute for Solar Energy Systems ISE

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