TECHNICKÝ SKÚŠOBNÝ ÚSTAV PIEŠŤANY, š.p.

Annex to Solar Keymark Certificate

Licence Number	**TSU 003-20**
Date issued	**2020-10-12**
Issued by	**TSU Piešťany, š.p.**

Licence holder	**VacuSol, spol. s r.o.**	**Country**	Czech Republic
Brand (optional)		**Web**	www.vacusol.cz
Street, Number	Dolní Rožinka 149	**E-mail**	info@vacusol.cz
Postcode, City	592 51 Dolní Rožinka	**Tel**	+420 (0)456016080

Collector Type	Evacuated tubular collector

Collector name	**Gross area (A_G)**	**Gross length**	**Gross width**	**Gross height**	**Power output per collector** Gb = 850 W/m2, Gd = 150 W/m2 & u = 1.3 m/s $\vartheta_m - \vartheta_a$					
					0 K	10 K	30 K	50 K	70 K	90 K
	m²	mm	mm	mm	W	W	W	W	W	W
VS 10T	1.45	2,150	675	120	672	655	618	577	533	486
Power output per m² gross area					464	452	426	398	368	335

Performance parameters test method	Steady state - outdoor									
Performance parameters (related to A_G)	η0, b	a1	a2	a3	a4	a5	a6	a7	a8	Kd
Units	-	W/(m²K)	W/(m²K²)	J/(m³K)	-	J/(m²K)	s/m	W/(m²K⁴)	W/(m²K⁴)	-
Test results	0.470	1.16	0.003	0.000	0.00	2,750	0.000	0.00	0.0E+00	0.91

Incidence angle modifier test method		Steady state - outdoor							
Incidence angle modifier	Angle	10°	20°	30°	40°	50°	60°	70°	80°	90°
Transversal	$K_{\theta T,coll}$	1.01	1.02	1.03	1.03	1.01	0.98	0.85	0.50	0.00
Longitudinal	$K_{\theta L,coll}$	0.99	0.99	0.97	0.94	0.89	0.80	0.62	0.35	0.00

Heat transfer medium for testing	Water		
Flow rate for testing (per gross area, A_G)	dm/dt	0.008	kg/(sm²)
Maximum temperature difference during thermal performance test	$(\vartheta_m-\vartheta_a)_{max}$	60	K
Standard stagnation temperature (G = 1000 W/m²; ϑ_a = 30 °C)	ϑ_{stg}	178	°C
Maximum operating temperature	ϑ_{max_op}	100	°C
Maximum operating pressure	$p_{max,op}$	600	kPa

Testing laboratory	Technický skúšobný ústav Piešťany, š.p	http://www.tsu.sk	
Test report(s)	190700007/PQ	**Dated**	12-10-2020

Comments of testing laboratory Datasheet version: 6.1, 2019-09-26

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Krajinská cesta 2929/9
92101 PIEŠŤANY
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Technický skúšobný ústav Piešťany, š.p.
Address: Krajinská cesta 2929/9, 92101 Piešťany, Slovak Republic
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Supplementary Information	Issued	2020-10-12

Annual collector output in kWh/collector at mean fluid temperature ϑ_m

Standard Locations		Athens			Davos			Stockholm			Würzburg		
Collector name	ϑ_m	25°C	50°C	75°C	25°C	50°C	75°C	25°C	50°C	75°C	25°C	50°C	75°C
VS 10T		1,116	941	774	929	771	627	672	539	425	723	580	454
Annual output per m² gross area		770	649	534	641	532	433	463	372	293	498	400	313
Annual efficiency, η_a		44%	37%	30%	39%	33%	27%	40%	32%	25%	40%	32%	25%
Fixed or tracking collector		Fixed (slope = latitude - 15°; rounded to nearest 5°)											
Annual irradiation on collector plane		1765 kWh/m²			1630 kWh/m²			1166 kWh/m²			1244 kWh/m²		
Mean annual ambient air temperature		18.5°C			3.2°C			7.5°C			9.0°C		
Collector orientation or tracking mode		South, 25°			South, 30°			South, 45°			South, 35°		

The collector is operated at constant temperature ϑm (mean of in- and outlet temperatures). The calculation of the annual collector performance is performed with the official Solar Keymark spreadsheet tool Scenocalc Ver. 6.1 (September 2019). A detailed description of the calculations is available at http://www.estif.org/solarkeymarknew/

Additional Information

Collector heat transfer medium				Water-Glycole	
The collector is deemed to be suitable for roof integration				No	
The collector was tested successfully under the following conditions:					
Climate class (A+, A, B or C)				A	--
G (W/m²) >	1000	ϑ_a (°C) >	20	H_x (MJ/m²) >	600
Maximum tested positive load				2300	Pa
Maximum tested negative load				1600	Pa
Hail resistance using steel ball (maximum drop height)				1.6	m

Additional collector attribute(s)

☐ Using external power source(s) for normal operation	☐ Active or passive measure(s) for self-protection
☐ Co-generating thermal and electrical power	☑ Façade collector(s)

Energy Labelling Information

	Reference Area, A_{sol} (m²)
VS 10T	1.45

Data required for CDR (EU) No 811/2013 - Reference Area A_{sol}

Collector efficiency (η_{col})	41%

Remark: Collector efficiency (ηcol) is defined in CDR (EU) No 811/2013 as collector efficiency of the solar collector at a temperature difference between the solar collector and the surrounding air of 40 K and a global solar irradiance of 1000 W/m², expressed in % and rounded to the nearest integer. Deviating from the regulation ηcol is based on reference area (Asol) which is aperture area for values according to EN 12975-2 or gross area for ISO 9806:2017.

Additional Informative Technical Data

Hydraulic Designation Code	Aperature Area, A_a (m²)
10-V-12S-9,1940-16,725-D	1.01

Data required for CDR (EU) No 812/2013 - Reference Area A_{sol}

Zero-loss efficiency (η_0)	0.46	--
First-order coefficient (a_1)	1.16	W/(m²K)
Second-order coefficient (a_2)	0.003	W/(m²K²)
Incidence angle modifier IAM (50°)	0.89	--

Remark: The data given in this section are related to collector reference area (A_{sol}) which is aperture area for values according to EN 12975-2 or gross area for ISO 9806. Consistent data sets for either aperture or gross area can be used in calculations like in the regulation 811 and 812 and simulation programs.

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