



TECHNICAL MANUAL

SOLAR SELECTIVE COLLECTOR

M4



OFFICIAL QUALITY MARK OF THE EUROPEAN UNION

Solar Keymark



DESCRIPTION

The M4 Calpak collectors are flat plate vertical or horizontal array collectors, with aluminium sheet absorbers, with vertical copper pipes welded onto them, ending, at their upper and lower ends, in two horizontal headers. The thermal fluid circulates between the vertical and horizontal pipe grid.

The surface processing of the aluminium sheet is of selective quality, achieved with the ecological "Sputtering" method by TINOX. These surfaces have a great advantage in that, while absorbing solar energy, they operate as black bodies (high absorptivity), but when they themselves radiate, they operate like mirrors (minimum radiation $\epsilon \ll 3.5\%$), thus achieving a significant decrease of the collector's thermal losses. In this respect, they are better than simple collectors with black solar paint, or with a lower quality selective processing.

- The copper pipe grid consists of vertical $\Phi 8$ tubes, spaced at 100mm intervals, and welded onto the 0.3mm aluminium sheets with UTRASONIC technology. The small distance, the thickness of the aluminium and the proper welding, maximises the transfer of heat from the heated aluminium sheet to the vertical pipes and, finally, to the thermal fluid circulating inside them.
- To reduce flow friction, the headers have a diameter of $\Phi 22$.
- The absorbers are placed inside a double-walled aluminium frame, with a recess-groove at its perimeter, in which 10 M8x16 screws are inserted, to facilitate installation.
- On the front, there is a clear safety glass cover (low iron, mistlite, tempered), 3.2 mm thick, that is fitted on the aluminium frame with mechanical clamping, with an inserted EPDM gasket, resulting in much better waterproofing.
- On the back, and around the absorber, there is thermal insulation with 50kg/m³ density, 40mm thick rock wool.
- The back of the collector is a 0.5 mm aluminium sheet, for mechanical protection of the rock wool.
- The frame consists of double-wall aluminium profile. The aluminium is painted with RAL7021 electrostatic paint, and is 1.2 mm thick, for maximum robustness and less lateral thermal losses.
- The operating pressure of the closed circuit of the collectors can be 6 or 10 bar, depending on the design, considering that collectors can withstand even higher pressures.
- The Calpak M4 collectors are designed for installation on flat roofs and pitched tiled roofs, by using the corresponding bases that are available as accessories.

ANTIFREEZE PROTECTION OF COLLECTORS

In order to ensure the anti-freeze protection of the collector, we offer the Calpak NOX thermal fluid, which is a product based on the non-toxic pharmaceutical propylene glycol (accessory). This thermal fluid is mixed with water, at a minimum volume ratio of 20%.

In areas with low winter temperatures, this ratio changes, as shown in the table below:

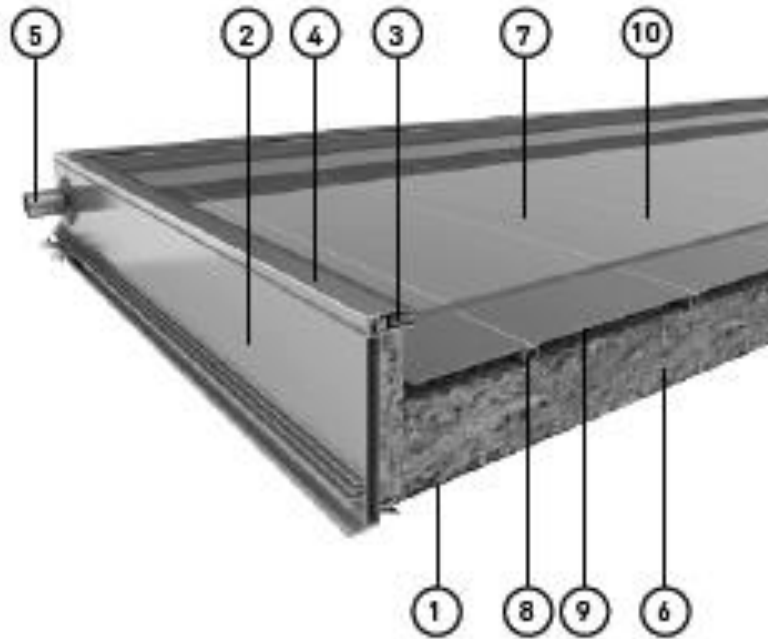
Minimum ambient temperature °C	-5	-10	-15	-20	-25	-30	-35
Ratio of Calpak NOX-water by volume %	20	23	31	37	43	48	53

These collectors, due to their selective properties and the reduced thermal losses, are appropriate for countries and regions with cold winters for producing hot water, and are a good solution for central solar heating systems of premises, for large central systems (hotels, hospitals, etc.), as well as industrial applications.

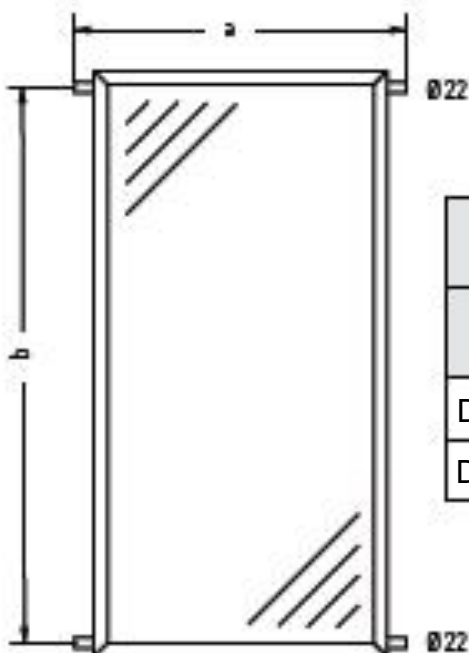
The SOLAR KEY MARK quality and performance label of the Calpak M4 collectors is a certification awarded by the European Union (CEN). To obtain it, on the one hand, thorough testing by recognised laboratories (e.g. NCSR 'Demokritos') or foreign laboratories (Stuttgart University, etc.) must take place, based on European standards EN 12975-1-2, and, on the other, they must be manufactured under conditions set out by the ISO 9001:2000 standards.



COLLECTOR CROSS SECTION



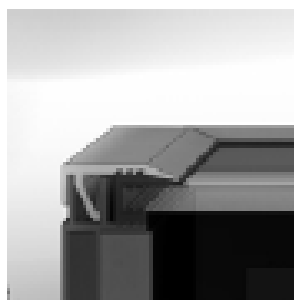
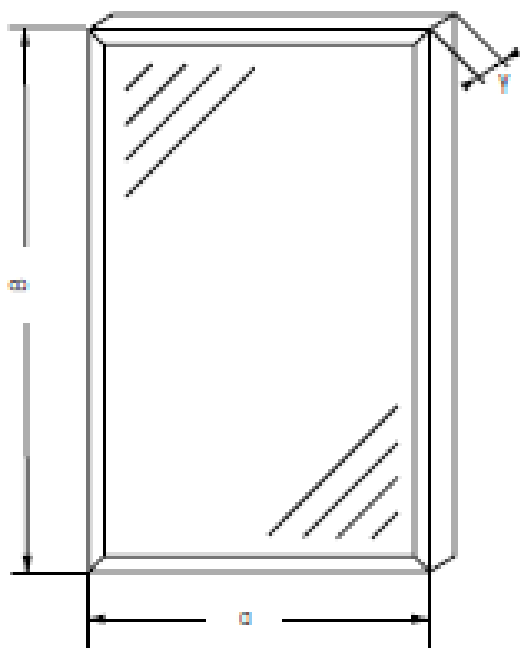
1. Back of 0.5mm aluminium sheet
2. Double-wall 1.2mm thick aluminium frame, painted with RAL7021 electrostatic paint.
3. EPDM sealing gasket
4. Aluminium clamp painted with RAL7021 electrostatic paint
5. Absorber header of $\Phi 22$ copper pipe
6. Thermal insulation with rock wool with 50kg/m² density and 40mm thickness
7. Low iron ($T\alpha = 91.5\%$), mistlite, tempered safety glass, 3.2 mm thick
8. Vertical copper $\Phi 8$ pipes
9. Absorber with 0.3mm thick aluminium sheets and with selective surface processing by TINOX ($\alpha=0.95$, $e=0.035$)
10. Welding of flaps on the vertical tubes with the ultrasonic method



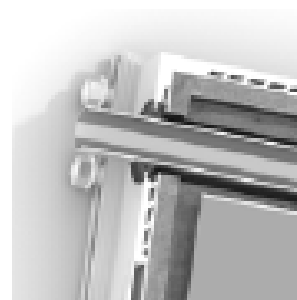
Distances of hydraulic connections						
Type of Collector	M4 200	M4 210	M4 260	M4 260H	M4 300	M4 300 H
Distance a (mm)	1035	1293	1293	2170	1563	2060
Distance b (mm)	1973	1613	2023	1146	1913	1416

TECHNICAL CHARACTERISTICS

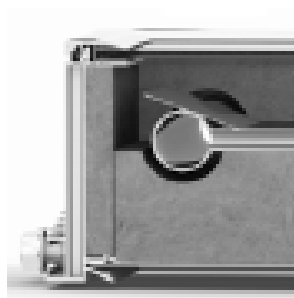
Type of Collector		M4 200	M4 210	M4 260	M4 260H	M4 300	M4 300 H
Total surface area	m ²	2.04	2.13	2.64	2.64	3.00	3.00
Window surface	m ²	1.87	1.96	2.44	2.44	2.83	2.83
Absorber surface	m ²	1.82	1.91	2.40	2.40	2.78	2.78
Dimension: width (a)	mm	986	1244	1244	2121	1502	1996
Dimension: height (b)	mm	2071	1711	2121	1244	1996	1502
Dimension: thickness (c)	mm	86	86	86	86	86	86
Active heat capacity	KJ/k	12	12.1	13.9	13.9	29	29
Weight (empty)	kg	34.5	36	42	42	50	50
Content of thermal fluid	l	1.60	1.60	1.8	1.8	2.0	2.0
Max. operating pressure	kPa/bar	1000/10	1000/10	1000/10	1000/10	1000/10	1000/10
Standby temperature	°C	177.6	177.6	177.6	177.6	177.6	177.6
Hydraulic connections (copper pipe).		Φ22	Φ22	Φ22	Φ22	Φ22	Φ22
Time constant	sec	59.7	59.7	59.7	59.7	59.7	59.7
Coefficient of angle of incidence at 50°		0.85	0.85	0.85	0.85	0.86	0.86
Annual energy performance in Athens (tm=25°C)	Kwh	1738	1821	2267	2267	2630	2630
Annual energy performance in Athens (tm=25°C)	Kwh	1104	1157	1440	1440	1670	1670



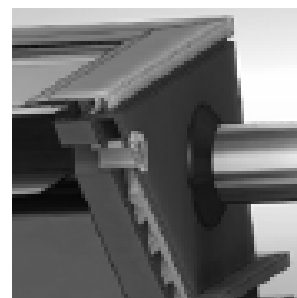
The Φ8 ventilation hole is equipped with louvres to prevent the entry of insects.



Header cover to maximise performance and for the aesthetic appearance of the collector.



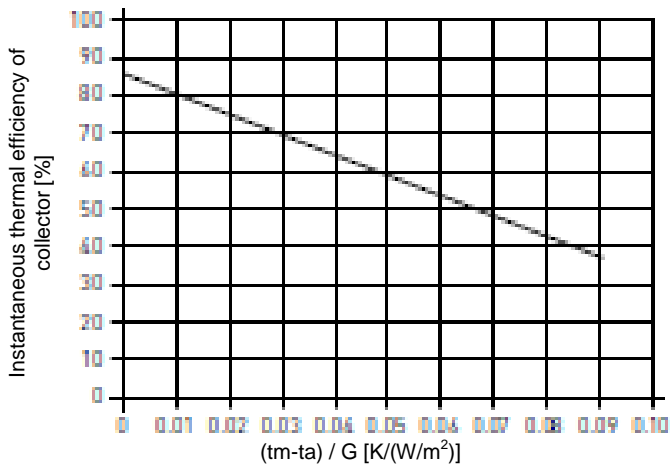
Aluminium angle inside the double wall of the frame profile reinforces the robustness and helps reduce thermal losses.



The thick clamp, after pressing, offers the greatest possible waterproofing of the collector.

Instantaneous Efficiency Curve of Calpak M4 solar collectors

based on the absorber surface



$$\eta = \frac{Q}{A G}$$

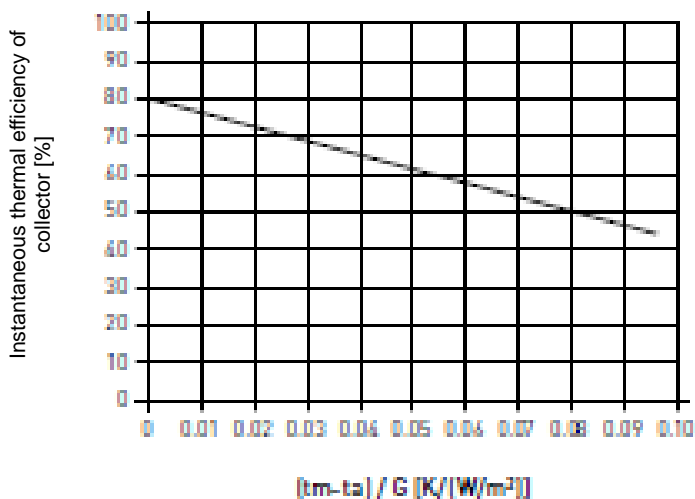
$$\eta = \eta_0 - U \frac{t_m - t_A}{G}$$

Type	M4
η_0	0.87
U	5.80

- Q = Effective output power of the collector (w)
- G = Total solar radiation intensity (w/m²)
- A = Collector absorber area (m²)
- n = Collector thermal output (%)
- U = Total coefficient of collector losses (w/m²,k)
- t_A = ambient temperature °C
- t_m = Mean temperature of heat transfer fluid °C

Secondary Equation of Instantaneous Performance of Solar Collectors M4

Based on the window surface



$$\eta = \eta_0 - a_1 \frac{t_m - t_A}{G} - a_2 G \frac{(t_m - t_A)^2}{G}$$

Type	M4	
η_0	0.80	
a_1	3.56	W/m2k
a_2	0.003	W/m2k2

Decrease of performance, due to tilt and orientation

- Falling sun radiation on flat Collectors (w/m^2) in the Athens Area

tilt	0	10	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90
Jan	66	80	91	96	100	104	107	109	111	112	113	112	111	109	107	104	100
Feb	75	84	91	93	96	97	99	99	99	99	98	96	94	91	88	84	80
Mar	104	112	116	118	119	119	119	118	116	114	111	108	104	99	94	89	83
Apr	146	151	152	152	151	149	147	143	139	134	129	123	116	108	101	92	84
May	182	183	181	178	175	170	165	159	153	145	137	128	119	109	100	90	79
Jun	200	200	195	191	185	180	173	166	158	149	139	128	118	108	96	85	75
Jul	213	214	210	205	199	194	187	180	171	162	151	139	128	117	105	91	80
Aug	200	206	206	204	202	199	194	188	182	174	165	155	144	132	121	109	96
Sep	156	168	176	179	180	181	180	178	175	171	166	161	154	146	138	128	118
Oct	106	120	130	134	138	140	142	143	142	142	140	137	134	130	125	119	113
Nov	66	77	86	90	94	96	99	100	101	102	102	101	99	97	95	92	88
Dec	53	63	72	76	79	82	85	87	88	89	89	89	88	87	85	83	80
S1	1567	1658	1706	1716	1718	1711	1697	1670	1635	1593	1540	1477	1409	1334	1252	1165	1075
S2	1203	1242	1250	1243	1230	1213	1188	1157	1120	1077	1027	971	913	850	784	714	645
S3	364	416	456	473	488	498	509	513	515	516	513	506	496	484	468	450	430

The tilt is in degrees (°) to horizontal

Σ1= Total solar radiation throughout the year

Σ2= Total solar radiation from April 1st to October 31st

Σ3= Total solar radiation from November 1st to March 31st

- Optimum tilt angle for collectors depending on use

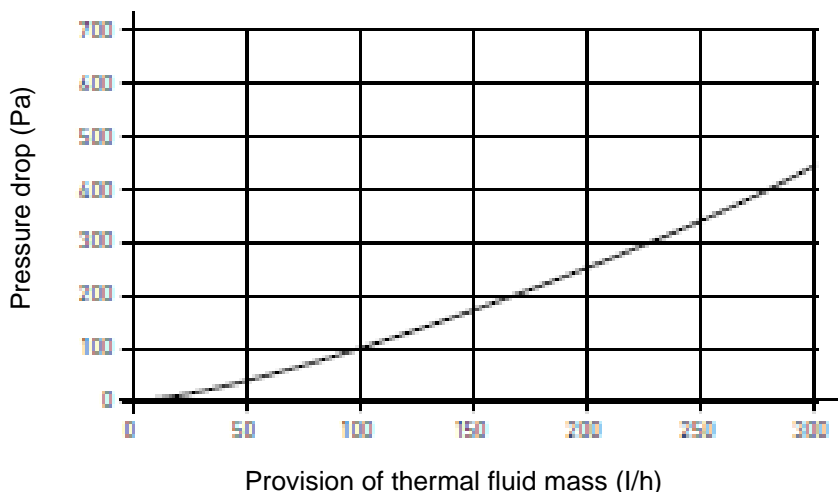
Usage	Optimum tilt angle
Production of Hot Water for use (throughout the year)	30° - 45°
Production of Hot Water for Use (summer, Apr-Oct)	15° - 30°
Hot Water for Use (throughout the year) + space heating	45° - 60°
Hot Water for Use (throughout the year) + swimming pool	30° - 45°
Hot Water for Use (throughout the year) + space heating = swimming pool	45° - 60°

- Indicative table for anticipated performance drops based on orientation

SOUTH	SOUTH-EAST	SOUTH-WEST	EAST	WEST
0%	-11%	-7%	-35%	-30%

Note For operation in the summer only, the change in the horizontal tilt from 45° to 15° does not significantly affect the thermal performance of the solar system.

Curve of Average drop of pressure of thermal fluid in M4 Collectors



Recommended flow of thermal fluid 30-40 l/m² (collector) h

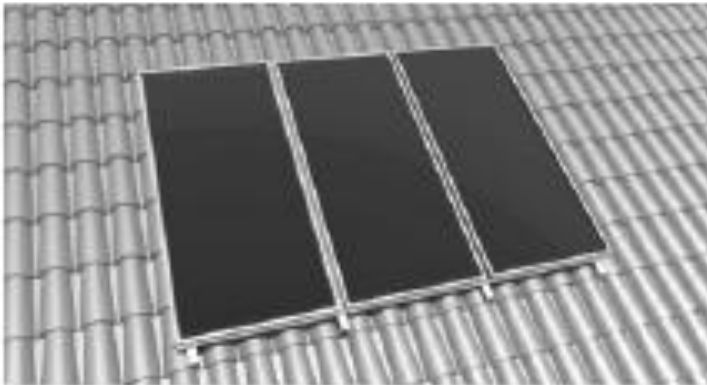
Recommended tilt of the collector towards the exit of the warm fluid 1-2%.

Accessories

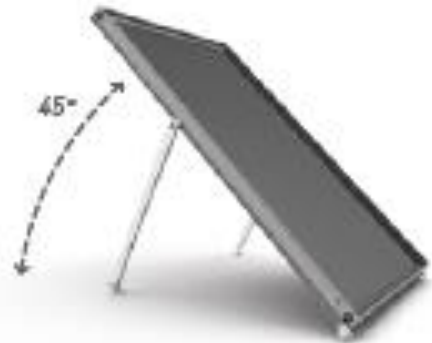
The following accessories are provided, to facilitate installation:

- Aluminium bases for flat roofs, with adjustable tilt
- Bases for pitched tiled roofs
- Set of $\Phi 22$ connectors
- Special collector covers for the best protection and prevention of overheating of the solar system in the summer, if it is not in use.
- Calpak NOX thermal fluid based on non-toxic pharmaceutical propylene glycol, packaged in 1-, 2-, 5- and 10-liter canisters.
- Automatic ventilators
- 'T', protection pockets and sensors
- Full range of solar stations for controlling the operation of central solar systems, with or without circulator

Base for installation on pitched tiled roof



Base for installation on flat roof



Calpak - CICERO HELLAS S.A.
9 SYNGROU AVENUE,
GR 11743,
ATHENS
Tel. 2109247250
Fax 2109231616
Email inforacalpak.gr
www.calpak.gr