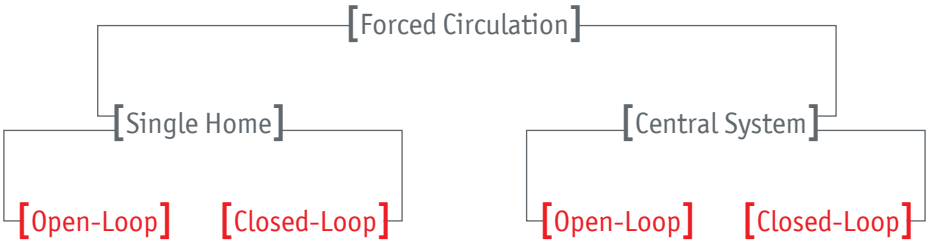
Technical Manual

Chromagen™
Solar Water Solutions

Chromagen is a world leader specializing in thermal solar energy systems. Founded in 1962 in Israel, Chromagen has years of experience in harnessing the sun's unlimited energy for the purpose of water heating. Chromagen provides systems designed for domestic use as well as more complex central systems for commercial applications in hotels, hospitals, apartment houses and industrial plants.

Meeting today's needs, while keeping tomorrow in mind, Chromagen, a major player in the global alternative energy arena, develops a range of efficient and reliable products. Chromagen provides clean, dependable solutions for your water heating needs.

Solar Thermal Systems



Products

Chromagen designs its solar energy systems and solutions to meet individual needs, and is involved in the planning and installation at every stage along the way. In addition to its systems, solar collectors and solar storage tanks, Chromagen provides accessories, such as stands and connectivity kits.

Solar Collectors

Chromagen manufactures solar collectors using state-of-the-art technology. Coated copper or aluminum fins are ultrasonically or laser welded to copper tubes encased in a frame and covered with tempered solar glass. Galvanized steel and aluminum case options are offered and absorbers are available with a variety of coating options: selective paint, black chrome and ultra-selective sputtering.

Solar Storage Tanks

Chromagen produces storage tanks in a range of sizes from 30 to 300 L that include: solar storage tanks and solar storage tanks with a heat-exchanger. All tanks are available with an electrical back up and are enamel coated. Tanks can be mounted either vertically or horizontally.

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[5] Thermosiphon System Installation

[6] Forced Circulation System Installation

[7] Troubleshooting and Maintenance

[8] Accessories

1 Introduction

1.1 About This Manual

This manual provides the following information:

[a] Solar water heating systems' principles

[b] Chromagen products - collectors and storage tanks

[c] Specifications, installation and maintenance of Chromagen's residential solar water heating systems

Chromagen uses the most advanced production techniques in order to ensure durable products. Read this manual thoroughly before beginning work. If any questions arise please contact your local dealer or Chromagen's head office.

1.2 Systems Introduction

Chromagen products may be assembled into four different system types:

[·] Thermosiphon, closed-loop systems

[·] Thermosiphon, open-loop systems

[·] Forced circulation, closed-loop systems

[·] Forced circulation, open-loop systems

The differences and working principles of the different systems are described in clauses 1.5-1.7.

Thermosiphon systems are recommended whenever the tank may be located on the roof and the average ambient temperature doesn't go below 5°C. These systems' operational features are simpler than forced systems' features, as they do not involve any moving parts or electrical pumps. In forced systems, the water storage tank may be located anywhere, which is useful when there are aesthetic considerations, or when the roof structural support cannot hold the weight of a full tank.

1.3 Quality Assurance

Chromagen's quality management scheme meets the ISO 9001 standards. Our products are made from the highest quality raw materials, while modern production lines ensure a consistency of precision and finish. Chromagen systems and components are tested to comply with the European standard EN12975 for solar collectors and EN12976 for solar thermal systems, International standard Iso9806, Israeli standard, SRCC USA, Australian standard and more.

Numerous institutes worldwide have tested and approved Chromagen systems: Cener Spain, FSEC Florida, ITW Germany, SPF Switzerland, CSTB France, ENEA Italy, Bodycote Canada, SII Israel and others. Chromagen is proud to provide its customers with high quality, efficient products and to be an integral part of the worldwide quest for a cleaner environment by using renewable energy sources.

1.4 Solar Thermal Basics

A solar water heating system is made up of several important elements:

[a] One or more solar collectors mounted on the roof

[b] A storage tank, with or without an inner heat-exchanger

[c] An electrical pump for circulating the heat transfer fluid (in Forced systems only)

There are two solar water heating circulation types:

[a] Thermosiphon [TS]

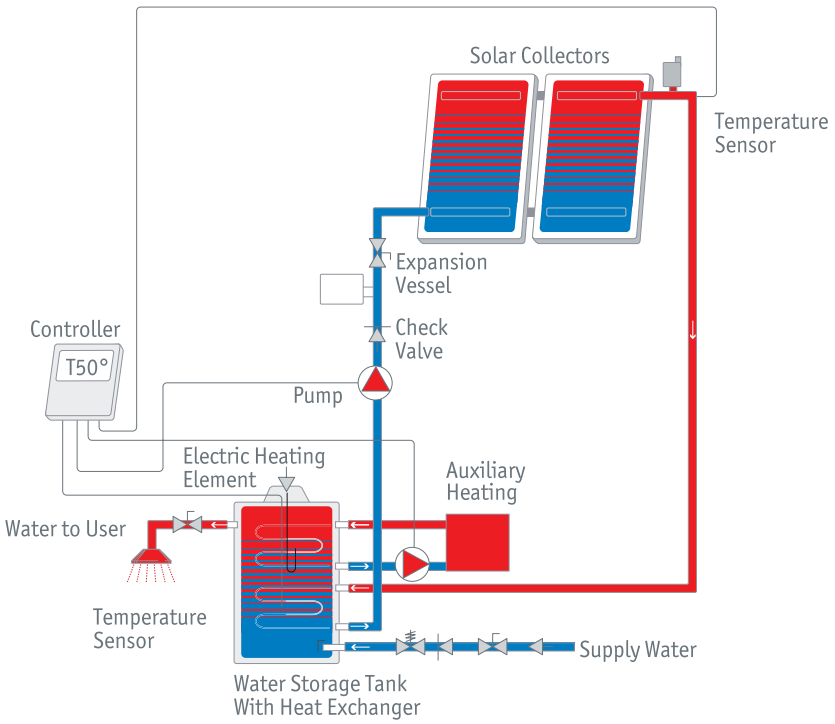
[b] Forced circulation [FC]

Forced circulation systems use electricity to power pumps that move liquid through the system. Thermosiphon systems rely on gravity to move liquid through the system. In both systems, the absorber plate of the collector gathers the sun's heat energy, which in turn warms the water or the anti-freeze solution that flows through an array of tubes. Once heated, the liquid flows through the tubes to the storage tank. The heated liquid warms the cooler water in the storage tank directly or through a heat-exchanger. A backup energy source, normally electricity or gas, supplies the energy deficit.

1.5 Forced Circulation System

FC systems use electrical pumps, valves, and controllers to circulate water or other heat-transfer fluids through the collectors. FC systems are usually less efficient and more expensive than TS systems however they enable high flexibility in the positioning of the systems' components: storage tanks do not need to be installed above or close to the collectors. Since FC systems use electricity to operate the pump, these systems will not function in a power outage.

Forced Circulation System - Schematic

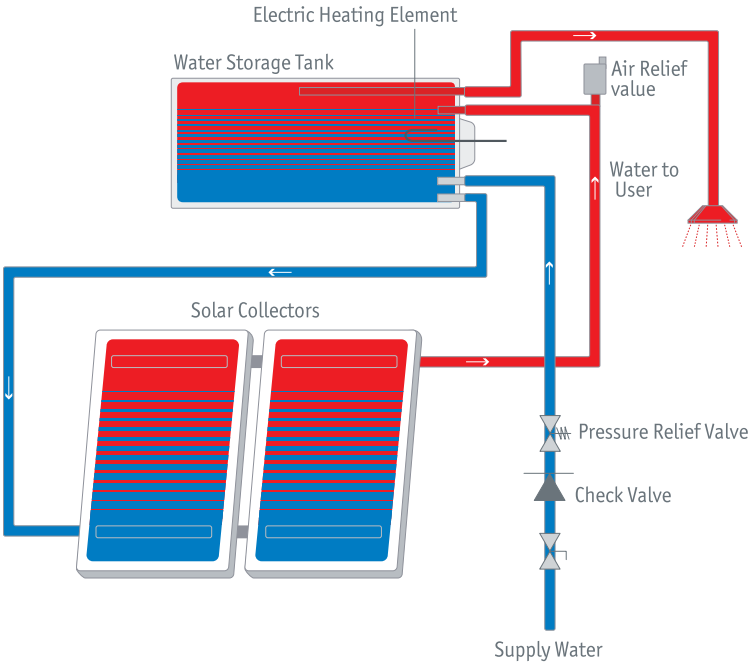


1.6 Thermosiphon System

In general, TS systems do not use electric-powered pumps to move liquid through tubes. Instead, they use the thermosiphon principal. These systems are easier to maintain, less expensive to install and generally more efficient than FC systems. However, they have installation limits since the storage tank must be placed above the lower part of the collector.

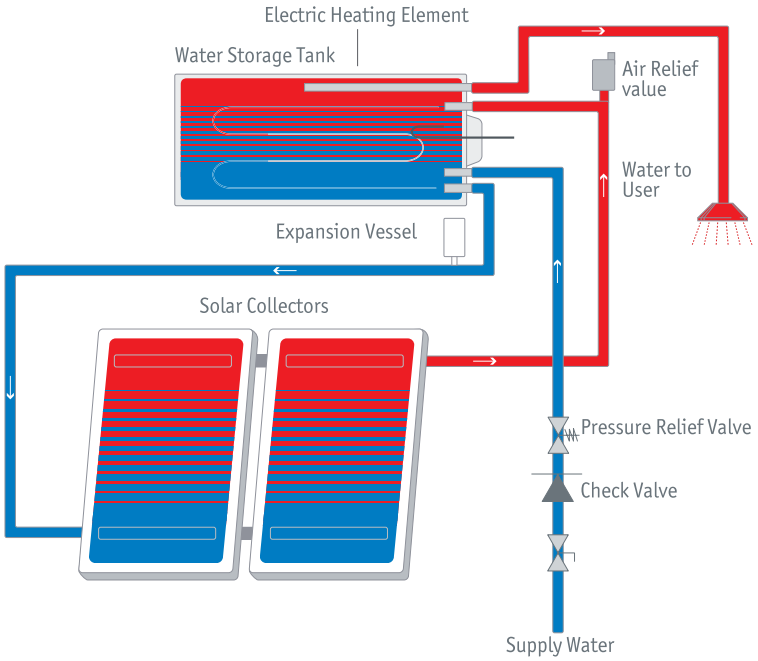
Thermosiphon systems use natural convection to circulate water through the solar collectors. As water in the collectors warms, it naturally rises to the upper part of the collector and from there to the storage tank. At this stage, the thermosiphoning action causes the cooler water in the tank to flow down the pipes to the bottom of the collector and naturally circulate throughout the system. The tank may be placed partly below the collector in a low profile configuration as shown in section 4.2. Low profile installation requires an additional check valve to prevent reverse thermosiphon flow.

Thermosiphon Open-Loop System-Schematic



[·] Tank must be located above the collectors
[·] Low profile mounting requires additional check valve

Thermosiphon Closed-Loop System-Schematic



[·] Tank must be located above the collectors
[·] Low profile mounting requires additional check valve

1.7 Closed-Loop and Open-Loop Systems

Closed-loop system; heat transfer fluid (water or anti-freeze solution) circulates through the system's tubes without mixing with the potable water inside the water storage tank. Closed-loop systems are better-suited for colder climates, since the anti-freeze solution keeps the system from freezing. In places with hard water, the system limits scale development inside the collector's tubes. Closed-loop systems can operate as FC or TS systems.

Open-loop systems operate like closed-loop systems with one major difference: anti-freeze fluid must not be used, since the hot water from the collector mixes with the supply water in the storage tank. Open-loop systems are best suited for warm climates; the water can freeze in colder climates and possibly destroy the system. In addition, these systems cannot be used in areas where the water is very "hard" or acidic, since this type of water is likely to corrode or block the system's tubes. Open-loop systems are commonly operated in a Thermosiphon mode.

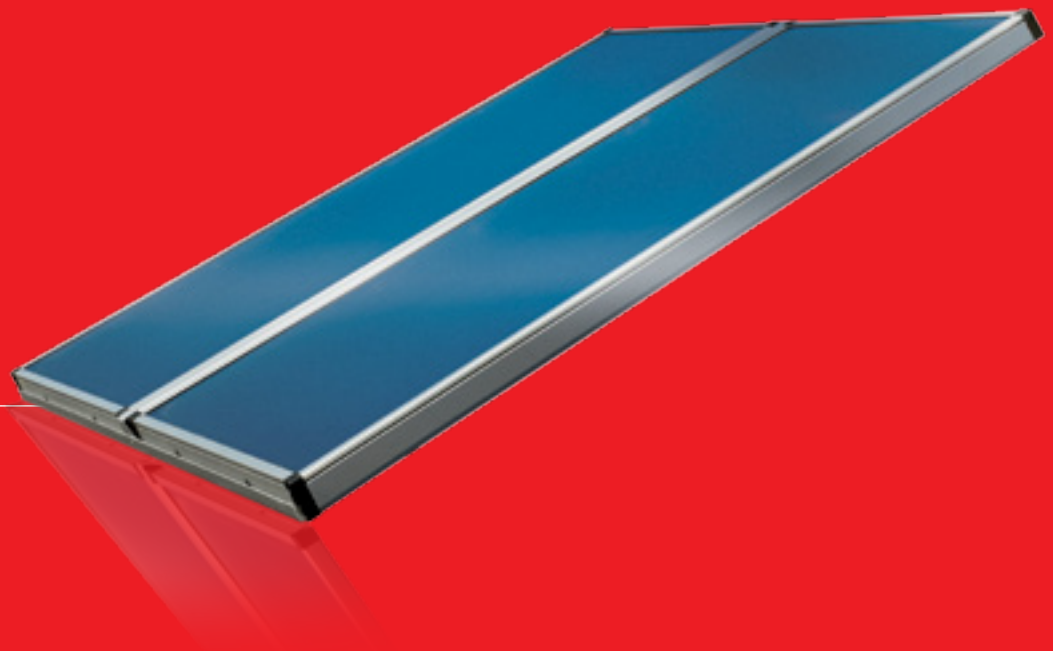
1.8 Water Quality

In regions where calcium carbonate content of water exceeds 250 mg/L (or 250 ppm) it is highly recommended that a closed-loop system is used. Collector clogging from mineral deposits is likely to impair collectors' functionality and shorten systems' life span wherever hard water is used in open-loop systems. For additional information review section 4.9.


Chromagen
Solar Water Solutions

2 

Flat-Plate Collectors



2.1 Introduction

Solar water heaters use solar collectors to capture the sun heat energy.
When water temperature below 80°C is required, flat-plate collectors are commonly used. A flat-plate collector is an insulated, weatherproofed box containing a dark absorber plate connected to an array of tubes and is covered by a transparent or translucent cover. A collector is typically 1 m wide, 2 m long and 10 cm in depth. The absorber plate gathers the sun's heat energy, which in turn warms the water (or anti-freeze solution) that flows through an array of tubes. Once heated, the liquid is pumped or naturally flows through the tubes to the storage tank. The heated liquid warms the cooler water in the storage tank directly or through a heat-exchanger.

Thermal Efficiency

The instantaneous efficiency of a solar collector, η, operating under steady state conditions, is defined as the ratio of the actual useful power extracted, $\dot{Q}$, to the solar energy intercepted by the collector, G•A.

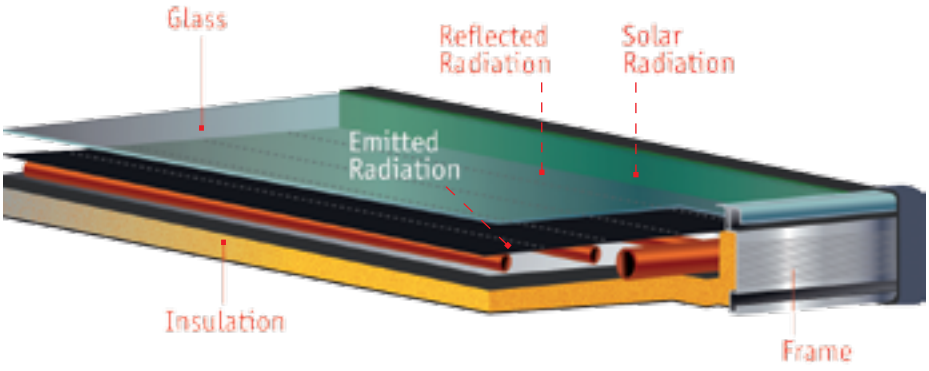
$$\eta_i = \frac{\dot{Q}}{G*A} \leq 1 \text{ (or } 100\%)$$

Where G is the global solar irradiance on the collector plane and A is the collectors aperture area:
$\dot{Q}$ is calculated from $\dot{Q} = \dot{m}_i C_p (T_{out} - T_{in})$ where $\dot{m}$ - flow rate through the collector; C_p - fluid specific heat; T_{in} - collector inlet temp; T_{out} - collector outlet temperature.

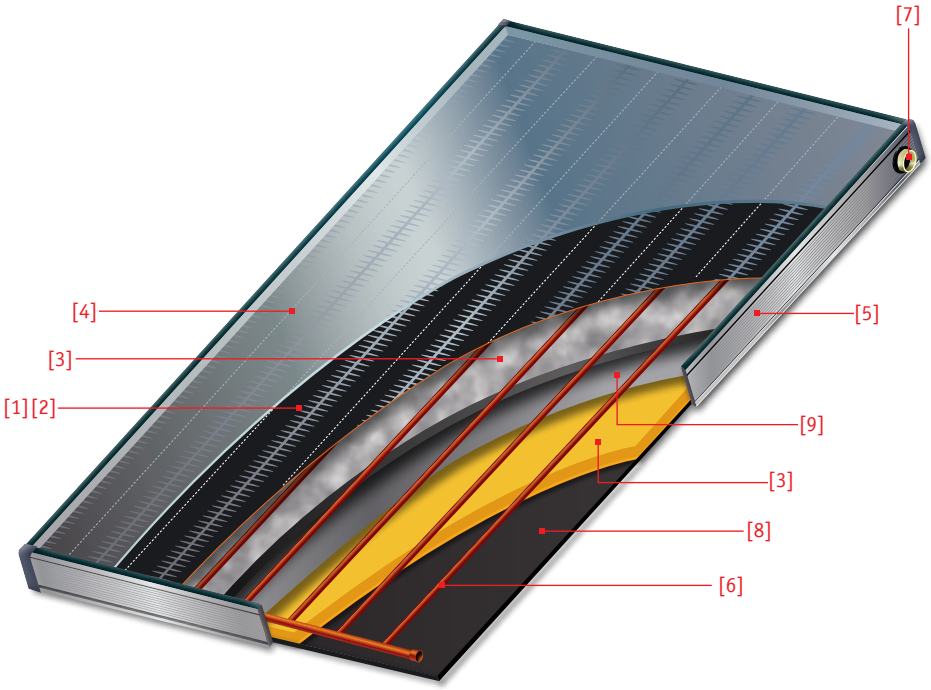
Selective Surface

The simple black painted surface can be improved and become more efficient by the use of selective coatings. Certain special coatings can reduce the re-radiation ability without markably reducing the energy-absorption ability.

Chromagen manufactures solar collectors using state-of-the-art technology.
Coated copper or aluminum fins are ultrasonically or laser welded to copper tubes encased in a frame and covered with tempered solar glass. Absorbers are available with a variety of coating options; selective paint, black chrome and ultra selective sputtering. Coated galvanized steel and anodized aluminum cases are available.



2.2 The Collector Parts



[1] Absorber Plate

Made of copper or aluminum sheet, laser or ultrasonically welded to copper tubes, ensuring high efficiency and durability.

[2] Absorber Plate Coating

Selective black paint, black chrome or ultra selective sputtered coating with excellent energy absorption and very low energy emission for high performance even in cooler climates.

[3] Insulation

The absorber plate is encased in 23 mm rigid polyurethane foam, with an option to additional layer of glass wool, retaining the collector's heat.

[4] Solar Glass Glazing

The single-pane 3.2 mm patterned and tempered solar glass has high solar transmittance of 91% and excellent durability.

[5] Casings

A. All anodized aluminum extrusion casings are made of solid construction available in a natural or black color.

B. Galvanized steel casings are available in black, gray or white polyester paint finish.

[6] Tubing Grid

16 mm or 8 mm copper risers brazed to 28 mm or 22 mm copper manifolds with optimal flow distribution.

[7] Piping Connection

Four 3/4" BSPP female brass adaptors or clear cut edge for connector brazing.

[8] Back Plate

The back plate is made of black polypropylene sheet.

[9] Aluminum Foil

The aluminum foil, integrated to the insulation, acts as a barrier against out-gassing.

2.3 Chromagen Collectors Specifications

Chromagen collectors are identified by the coating type, casing type and size.

Z series | black painted copper fins
S series | black chrome plated copper fins
A Series | black painted aluminum fins
P series | sputtered aluminum full plate absorber
Q series | black painted full plate aluminum absorber

Each series may be constructed with aluminum frame or painted galvanized steel frame.

A Frame | anodized aluminum black or natural aluminum color
R frame | galvanized steel frame-grey, black, white or un-painted
Each series is composed of four models or more, differing in dimension

	K (CR-90)		D (CR-100)		E (CR-110)		F (CR-120 V)	
Risers diameter	8 mm	16 mm	8 mm	16 mm	8 mm	16 mm	8 mm	16 mm
Gross area [m2]	1.65	1.65	2.02	2.02	2.34	2.34	2.77	2.77
Net aperture area [m2]	1.52	1.52	1.85	1.85	2.15	2.15	2.56	2.56
Length [cm]	181	181	189	189	218	218	218	218
Width [cm]	91	91	107	107	107	107	127	127
Thickness [cm]	9	9	9	9	9	9	9	9
Weight (empty) [kg]	26	28	30	33	34	37	39	43
Fluid capacity [L]	1.0	2.7	1.2	3.2	1.3	3.6	1.5	4.1

	G (CR-120 H)		W (CR-130)		Z (CR-135)		U (CR-140)	
Risers diameter	8 mm	16 mm	8 mm	16 mm	8 mm	16 mm	8 mm	16 mm
Gross area [m2]	2.77	2.77	2.93	2.93	3.12	3.12	3.67	3.67
Net aperture area [m2]	2.56	2.56	2.73	2.73	2.93	2.93	3.44	3.44
Length [cm]	218	218	246	246	246	246	308	308
Width [cm]	127	127	119	119	127	127	119	119
Thickness [cm]	9	9	9	9	9	9	9	9
Weight (empty) [kg]	40	44	44	49	34	46	54	59
Fluid capacity [L]	2.0	5.1	1.7	5.3	2.1	7.1	2.6	6.3

Example | PA-D has sputtered aluminum absorber, aluminum frame & size D=189x107 cm

[·] Collectors test pressure: 12 bar [·] Max collector operation pressure: 8 bar

Coating Specifications

	Absorptance α	Emissivity ε	Stagnation Temp @1000W/m2 & ambient Temp 30°C
Selective paint	0.9	0.45	170°C
Black chrome	0.95	0.12	180°C
Sputtering	0.95	0.05	205°C

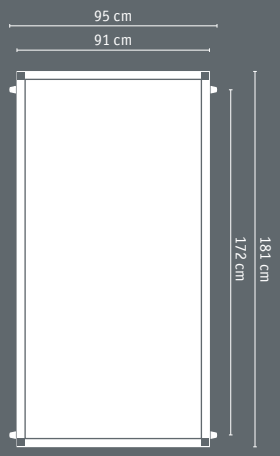
Glass Specifications

	Emissivity	Transmittance (Visible light)	Transmittance (Solar Radiation)	Thickness	Heat Conduction
	ε	τ_{D65}	τ_{SOL}	t [mm]	K[W/mk]
Float	0.85	0.90	0.86	2.8-3	1.00
Solar tempered	0.85	0.916	0.91	3-4	1.04

[·] Due to on-going development, specifications are subject to change without notice

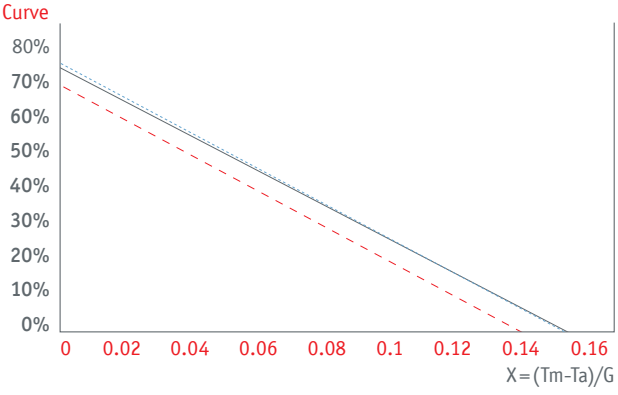
2.4
Collectors' Data Sheets

K(CR90)



Risers diameter	8 mm	5/8" (~16 mm)
Connections thread BSP (female)	3/4"	3/4"
Gross area [m2]	1.65	1.65
Net aperture area [m2]	1.52	1.52
Length [cm]	181	181
Width [cm]	91	91
Thickness [cm]	9	9
Weight (empty) [kg]	26	28
Fluid capacity [L]	1	2.7
Test pressure [bar]	12	12
Max. operating pressure [bar]	8	8
Efficiency curve (selective paint)	η=0.69- 4.2X	
Efficiency curve (black chrome)	η=0.72 - 4.1X	
Efficiency curve (sputtering)	η=0.74 - 4.2X	

Efficiency Curve



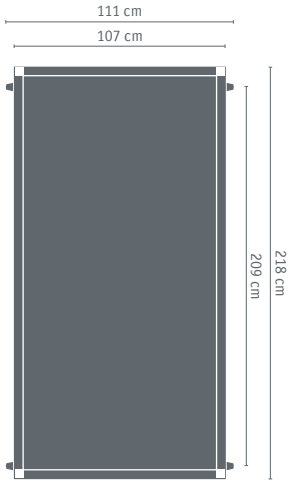
---- Sputtering
—— Black chrome
---- Selective paint
Tm= Water temp:(Tout + Tin)/2
Ta = Ambient temp
G = Instantaneous solar radiation

[·] The attached chart is for comparison purposes

[·] Efficiency curves based on aperture area

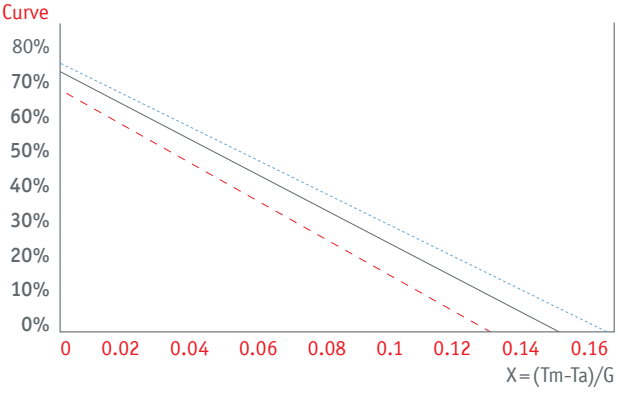
Flow [L / hr]	PRESS drop on one 16 mm COL. [cm of Water]	Pressure drop on one 8 mm COL. [cm of Water]
50	0.1	0.3
100	0.3	1
150	0.9	2.1
200	1.4	3.5
250	2.5	6
300	3.7	8
350	5.3	10.2

D(CR100)



Risers diameter	8 mm	5/8" (~16 mm)
Connections thread BSP (female)	3/4"	3/4"
Gross area [m2]	2.03	2.03
Net aperture area [m2]	1.85	1.85
Length [cm]	189	189
Width [cm]	107	107
Thickness [cm]	9	9
Weight (empty) [kg]	30	33
Fluid capacity [L]	1.2	3.2
Test pressure [bar]	12	12
Max. operating pressure [bar]	8	8
Efficiency curve (selective paint)	η=0.69- 4.7X	
Efficiency curve (black chrome)	η=0.73 - 4.2X	
Efficiency curve (sputtering)	η=0.75 - 3.9X	

Efficiency Curve



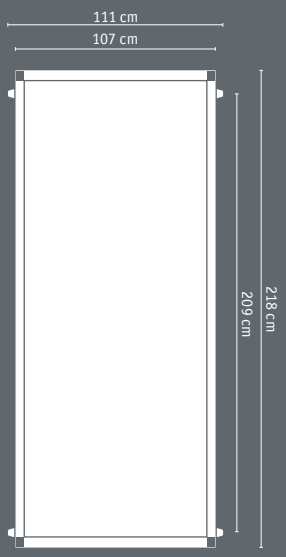
---- Sputtering
—— Black chrome
---- Selective paint
Tm= Water temp:(Tout + Tin)/2
Ta = Ambient temp
G = Instantaneous solar radiation

[·] The attached chart is for comparison purposes

[·] Efficiency curves based on aperture area

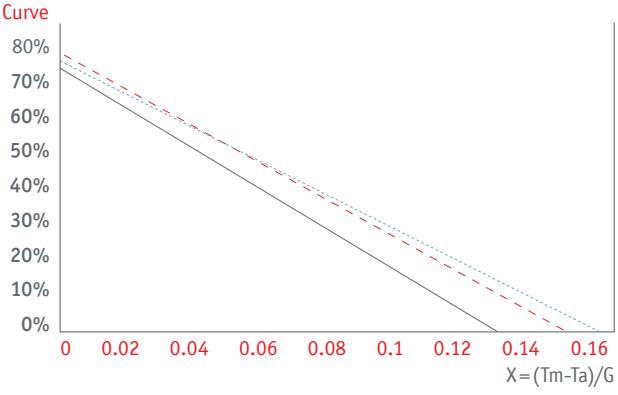
Flow [L / hr]	PRESS drop on one 16 mm COL. [cm of Water]	Pressure drop on one 8 mm COL. [cm of Water]
50	0.2	0.6
100	0.4	0.9
150	1.0	2.5
200	1.5	4
250	2.7	6.3
300	4.0	8.5
350	5.6	10.9

E(CR110)



	8 mm	5/8" (~16 mm)
Risers diameter		
Connections thread BSP (female)	3/4"	3/4"
Gross area [m2]	2.35	2.35
Net aperture area [m2]	2.15	2.15
Length [cm]	218	218
Width [cm]	107	107
Thickness [cm]	9	9
Weight (empty) [kg]	34	37
Fluid capacity [L]	1.3	3.6
Test pressure [bar]	12	12
Max. operating pressure [bar]	8	8
Efficiency curve (selective paint)	η=0.73- 4.9X	
Efficiency curve (black chrome)	η=0.76 - 4.3X	
Efficiency curve (sputtering)	η=0.75 - 3.9X	

Efficiency Curve



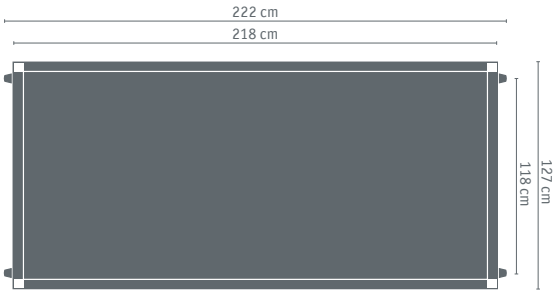
---- Sputtering
—— Black chrome
---- Selective paint
Tm= Water temp:(Tout + Tin)/2
Ta = Ambient temp
G = Instantaneous solar radiation

[·] The attached chart is for comparison purposes

[·] Efficiency curves based on aperture area

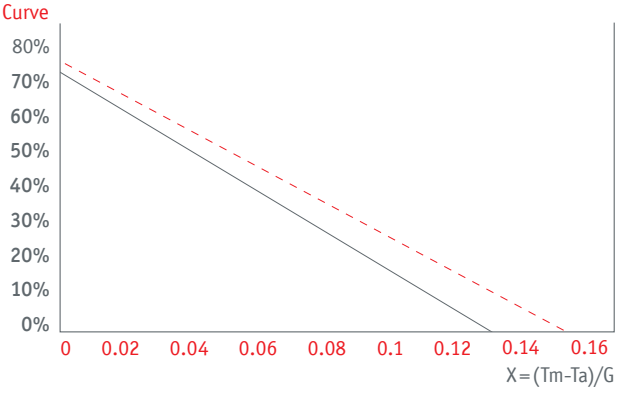
Flow [L / hr]	PRESS drop on one 16 mm COL. [cm of Water]	Pressure drop on one 8 mm COL. [cm of Water]
50	0.25	0.75
100	0.50	1.6
150	1.25	2.6
200	2.00	5
250	3.00	7
300	4.25	8.5
350	5.75	12

G(CR120)
Horizontal



Risers diameter	8 mm	5/8" (~16 mm)
Connections thread BSP (female)	3/4"	3/4"
Gross area [m2]	2.77	2.77
Net aperture area [m2]	2.56	2.56
Length [cm]	218	218
Width [cm]	127	127
Thickness [cm]	9	9
Weight (empty) [kg]	40	44
Fluid capacity [L]	2	5.1
Test pressure [bar]	12	12
Max. operating pressure [bar]	8	8
Efficiency curve (selective paint)	η=0.72- 4.8X	
Efficiency curve (black chrome)	η=0.75 - 4.1X	

Efficiency Curve



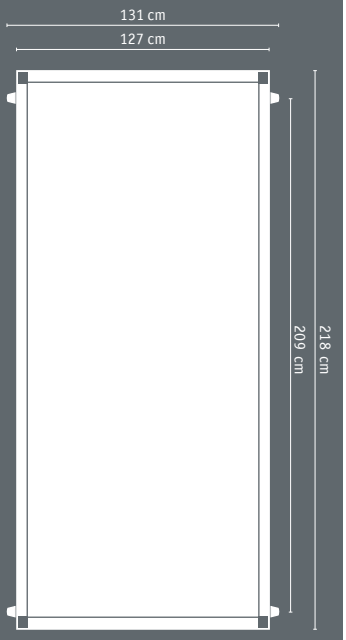
Black chrome
Selective paint
Tm= Water temp:(Tout + Tin)/2
Ta = Ambient temp
G = Instantaneous solar radiation

[·] The attached chart is for comparison purposes

[·] Efficiency curves based on aperture area

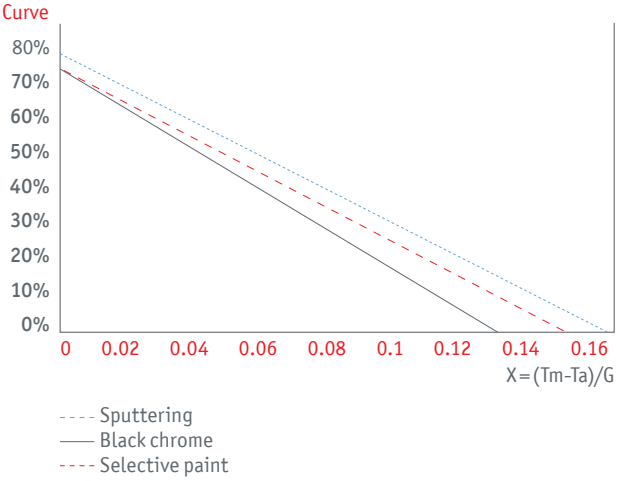
Flow [L / hr]	PRESS drop on one 16 mm COL. [cm of Water]	Pressure drop on one 8 mm COL. [cm of Water]
50	0.4	1.5
100	1	3
150	1.8	4.3
200	3	7.2
250	4.8	9.8
300	6	12.6
350	9	18

F(CR120)
Vertical



Risers diameter	8 mm	5/8" (~16 mm)
Connections thread BSP (female)	3/4"	3/4"
Gross area [m2]	2.77	2.77
Net aperture area [m2]	2.56	2.56
Length [cm]	218	218
Width [cm]	127	127
Thickness [cm]	9	9
Weight (empty) [kg]	39	43
Fluid capacity [L]	1.45	4.13
Test pressure [bar]	12	12
Max. operating pressure [bar]	8	8
Efficiency curve (selective paint)	η=0.72- 4.8X	
Efficiency curve (black chrome)	η=0.72 - 4.1X	
Efficiency curve (sputtering)	η=0.75 - 3.9X	

Efficiency Curve

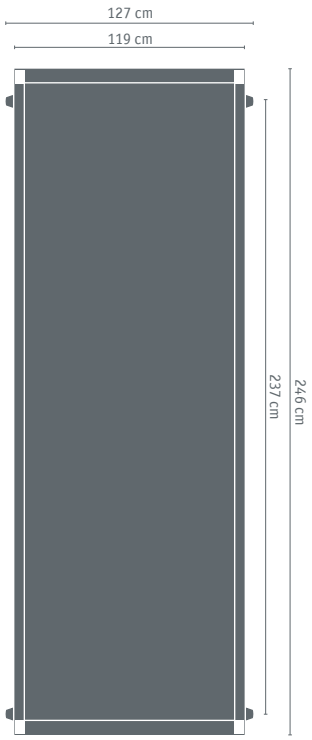


[·] The attached chart is for comparison purposes

[·] Efficiency curves based on aperture area

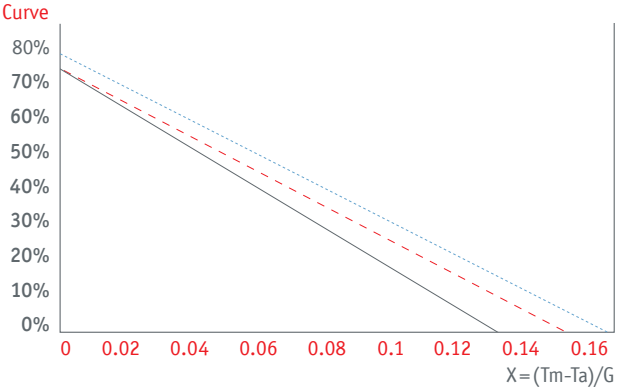
Flow [L / hr]	PRESS drop on one 16 mm COL. [cm of Water]	Pressure drop on one 8 mm COL. [cm of Water]
50	0.4	1.5
100	1	3
150	1.8	4.3
200	3	7.2
250	4.8	9.8
300	6	12.6
350	9	18

W(CR130)



Risers diameter	8 mm	5/8" (~16 mm)
Connections thread BSP (female)	3/4"	3/4"
Gross area [m2]	2.96	2.96
Net aperture area [m2]	2.73	2.73
Ratio net/gross area	0.93	0.92
Length [cm]	246	246
Width [cm]	119	119
Thickness [cm]	9	9
Weight (empty) [kg]	44	49
Fluid capacity [L]	1.7	5.3
Test pressure [bar]	12	12
Max. operating pressure [bar]	8	8
Efficiency curve (selective paint)	η=0.73- 4.9X	
Efficiency curve (black chrome)	η=0.74 - 4.2X	
Efficiency curve (sputtering)	η=0.75 - 3.9X	

Efficiency Curve



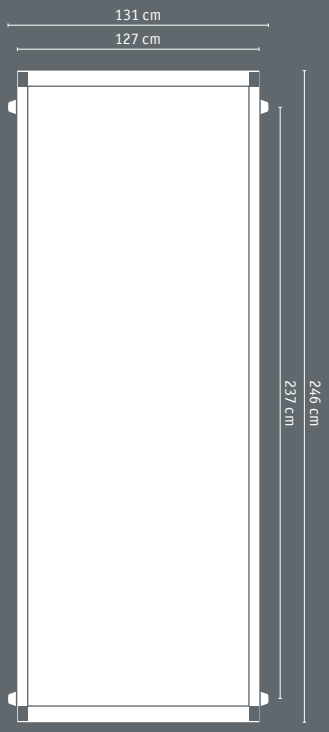
Sputtering
Black chrome
Selective paint
Tm= Water temp:(Tout + Tin)/2
Ta = Ambient temp
G = Instantaneous solar radiation

[·] The attached chart is for comparison purposes

[·] Efficiency curves based on aperture area

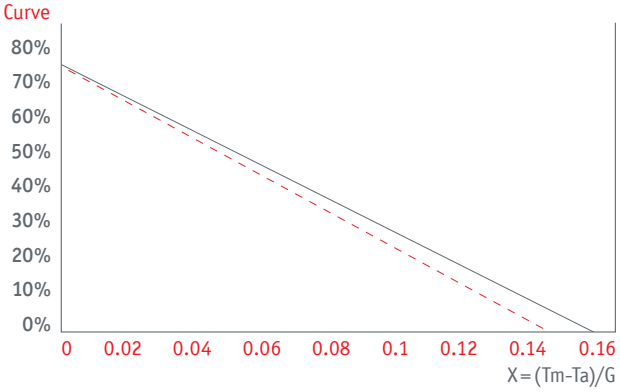
Flow [L / hr]	PRESS drop on one 16 mm COL. [cm of Water]	Pressure drop on one 8 mm COL. [cm of Water]
50	0.3	1
100	0.9	2.8
150	1.6	4
200	2.8	7
250	4.5	9.5
300	5.8	12.3
350	7.6	16.7

Z(CR135)



Risers diameter	8 mm	5/8" (~16 mm)
Connections thread BSP (female)	3/4"	3/4"
Gross area [m2]	3.12	3.12
Net aperture area [m2]	2.93	2.93
Length [cm]	246	246
Width [cm]	127	127
Thickness [cm]	9	9
Weight (empty) [kg]	46	54
Fluid capacity [L]	2.1	6.8
Test pressure [bar]	12	12
Max. operating pressure [bar]	8	8
Efficiency curve (sputtering)	η=0.76- 4.1X	
Efficiency curve (selective paint)	η=0.73 - 4.5X	

Efficiency Curve



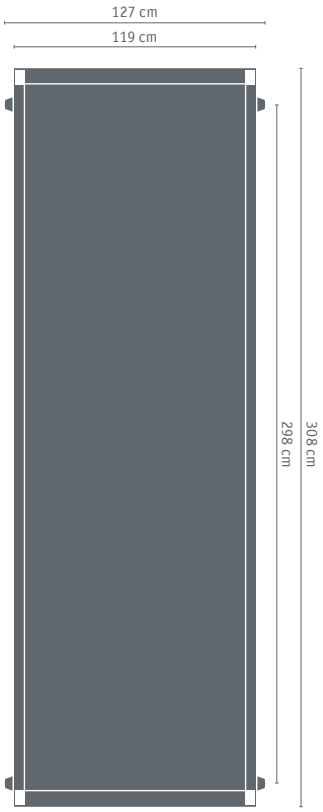
Black chrome
Selective paint
Tm = Water temp:(Tout + Tin)/2
Ta = Ambient temp
G = Instantaneous solar radiation

[·] The attached chart is for comparison purposes

[·] Efficiency curves based on aperture area

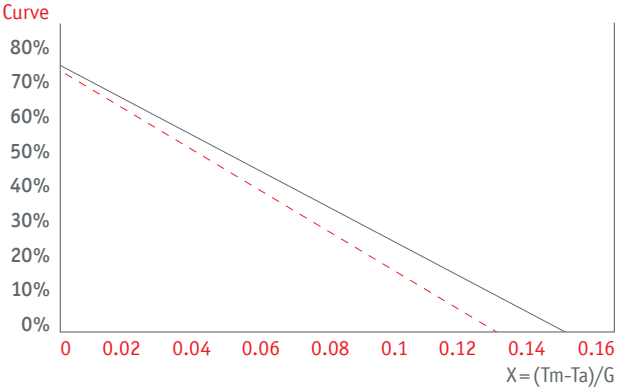
Flow [L / hr]	PRESS drop on one 16 mm COL. [cm of Water]	Pressure drop on one 8 mm COL. [cm of Water]
50	0.6	1.8
100	1.4	3.8
150	2.5	6.3
200	4	8.1
250	6	12.3
300	9	17.7
350	14	25

U(CR140)



Risers diameter	8 mm	5/8" (~16 mm)
Connections thread BSP (female)	3/4"	3/4"
Gross area [m2]	3.67	3.67
Net aperture area [m2]	3.44	3.44
Length [cm]	308	308
Width [cm]	119	119
Thickness [cm]	9	9
Weight (empty) [kg]	53	59
Fluid capacity [L]	1.9	6.3
Test pressure [bar]	12	12
Max. operating pressure [bar]	8	8
Efficiency curve (black chrome)	η=0.75- 4.3X	
Efficiency curve (selective paint)	η=0.73 - 5.0X	

Efficiency Curve



Black chrome
Selective paint
Tm= Water temp:(Tout + Tin)/2
Ta = Ambient temp
G = Instantaneous solar radiation

[·] The attached chart is for comparison purposes

[·] Efficiency curves based on aperture area

Flow [L / hr]	PRESS drop on one 16 mm COL. [cm of Water]	Pressure drop on one 8 mm COL. [cm of Water]
50	0.6	1.8
100	1.4	3.8
150	2.5	6.3
200	4	8.1
250	6	12.3
300	9	17.7
350	14	25

3 

Storage Tanks and Heat-Exchangers


Chromagen

3.1 Introduction

Thermo tanks are designed to store hot water for domestic or industrial use. The water inside the tank is heated through several options, as follows:

[·] Electrical heating | using an electric heating element dipped inside the tank

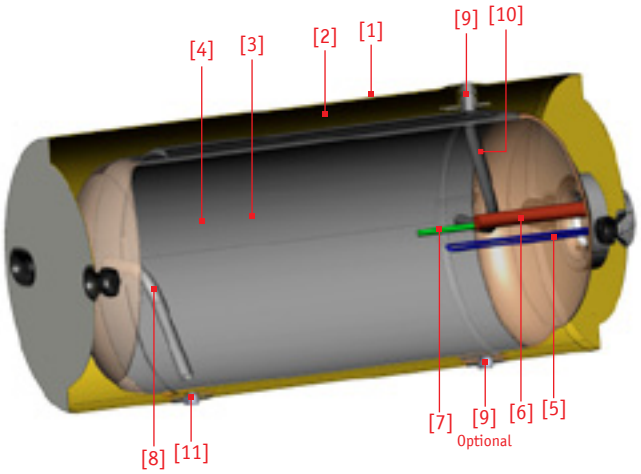
[·] Direct heating | hot water from a solar collector, mixed with tank water

[·] Indirect heating | using a special storage tank that includes a heat-exchanger connected to a water heating source (for example, collector, gas or wood heater)

The storage tank is insulated from the ambient air by a layer of injected polyurethane foam. Chromagen offers a wide selection of water storage tanks with capacity of 30 to 300 L. There are seven different types of solar tanks as shown in the following diagrams:

[·] The horizontal or vertical orientation options enable flexible installation according to customer requirements

3.2 Storage Tank Parts



[1] External coating | aluminum or polyester coated galvanized steel sheet providing extreme durability and an attractive finish

[2] Insulation | thick polyurethane insulation layer ensuring optimal insulation and heat retention

[3] Storage tank | constructed of thick steel, automatically welded, ensuring precision and enabling working pressure of 8 bars

[4] Enamel coating | internal glass-enamel layer protecting against corrosion

[5] Electric element | energy-efficient electric element with rapid heating time enabling the provision of hot water 24 hours a day, 365 days a year

[6] Sacrificial anode | anti-corrosion protection

[7] Thermostat | built-in thermostat ensuring that water inside the tank does not exceed a preset temperature, while using the electric element

[8] Cold water supply

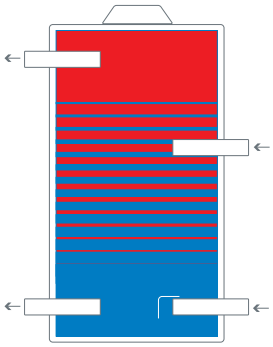
[9] Hot water from collector - inlet

[10] Hot water to user

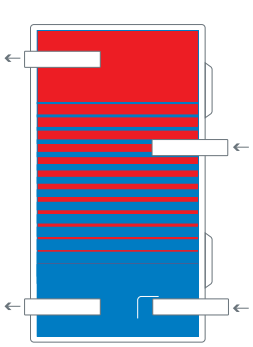
[11] Cold water to collector - outlet

3.3 Vertical and Horizontal Tanks

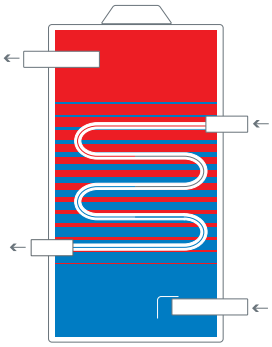
[Vertical Tanks]



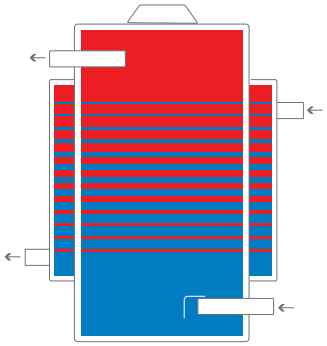
Solar
(Open-Loop System)



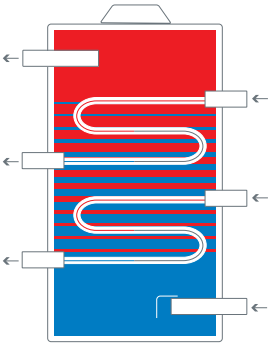
Solar
Side Flange



Spiral /Serpentine
Heat-Exchanger
(Closed-Loop System)

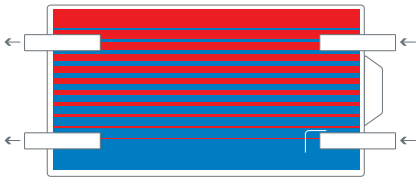


Double Jacket
Heat-Exchanger
(Closed-Loop System)

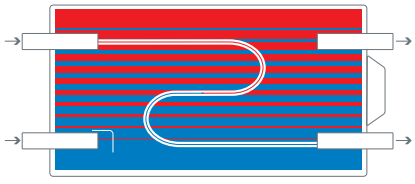


Double Spiral
Heat-Exchanger
(Closed-Loop System)

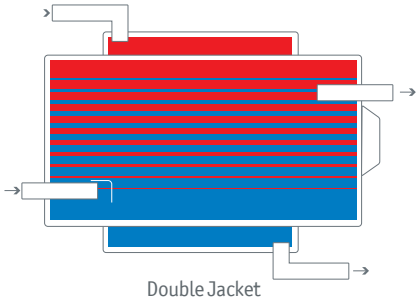
[Horizontal Tanks]



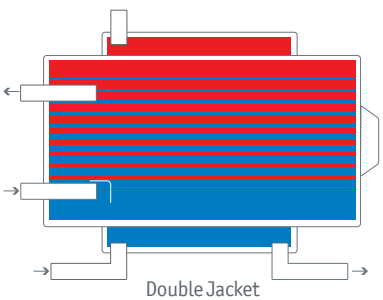
Solar
(Open-Loop System)



Spiral/Serpentine
Heat-Exchanger
(Closed-Loop System)



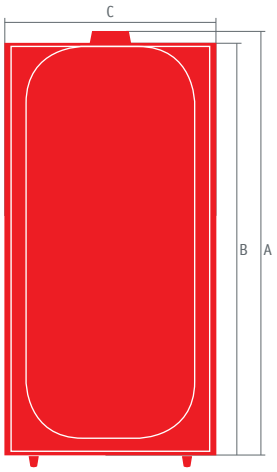
Double Jacket
Heat-Exchanger
(Closed-Loop System)



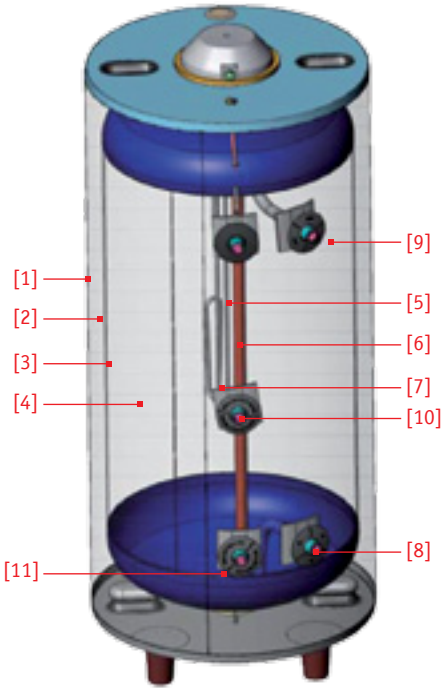
Double Jacket
Heat-Exchanger
(Closed-Loop System)

3.4 Storage Tanks' Data

Solar Vertical Tanks

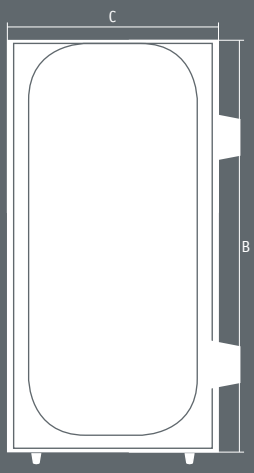


[1] External coating
[2] Insulation
[3] Storage tank
[4] Enamel coating
[5] Electric element
[6] Sacrificial anode
[7] Thermostat
[8] Cold water supply
[9] Hot water to user
[10] Hot water from collector - inlet
[11] Cold water to collector - outlet

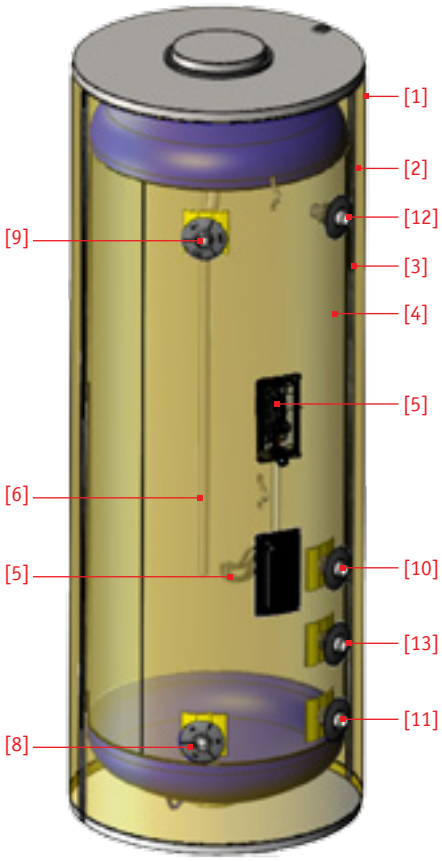


Capacity [L]	A [mm]	B [mm]	C [mm]	Weight [Kg]	Electric Element (kW)
150	1020	950	585	53	2.5
200	1270	1210	585	65	2.5
300	1420	1360	650	91	2.5 / 3.6

Solar
Vertical Tanks
Side Flange

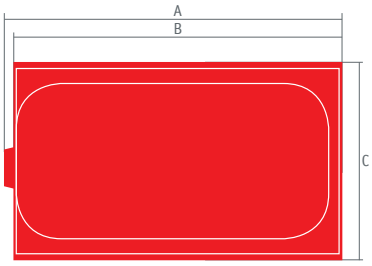


[1] External coating
[2] Insulation
[3] Storage tank
[4] Enamel coating
[5] Electric element
[6] Sacrificial anode
[7] Thermostat
[8] Cold water supply
[9] Hot water to user
[10] Hot water from collector - inlet
[11] Cold water to collector - outlet
[12] PT valve - inlet
[13] Sensor house - inlet

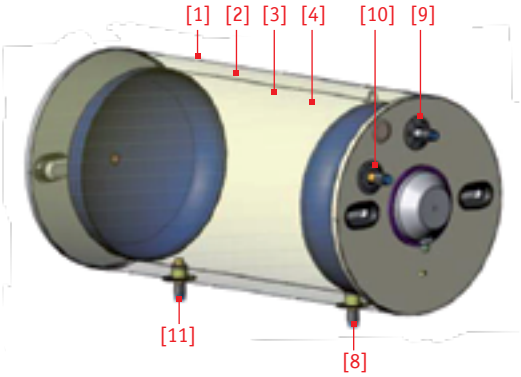


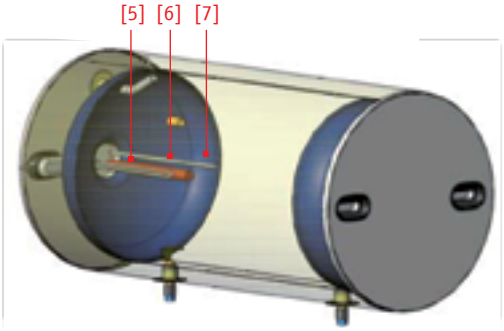
Capacity [L]	B [mm]	C [mm]	Weight [Kg]	Electric Element (kW)
400	1765	650	110	3.6
400 Industrial	1765	645	105	None

Solar
Horizontal Tanks



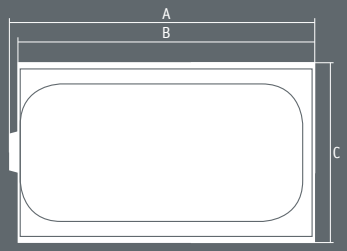
[1] External coating
[2] Insulation
[3] Storage tank
[4] Enamel coating
[5] Electric element
[6] Sacrificial anode
[7] Thermostat
[8] Cold water supply
[9] Hot water to user
[10] Hot water from collector - inlet
[11] Cold water to collector - outlet



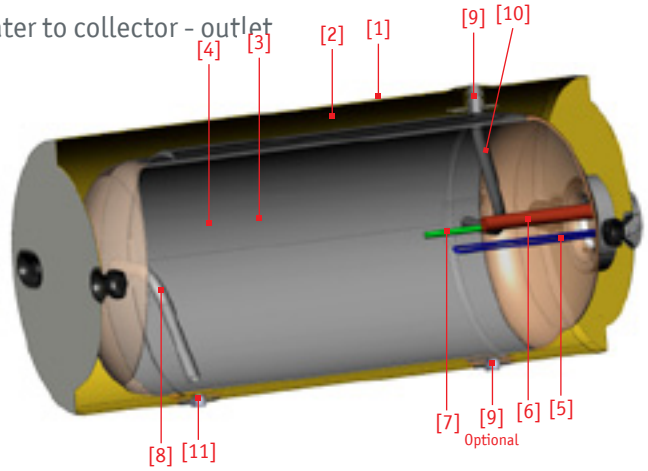


Capacity [L]	A [mm]	B [mm]	C [mm]	Weight [Kg]	Electric Element (kW)
120	860	800	560	46	2.5
150	1020	950	560	53	2.5
200	1270	1210	560	65	2.5
300	1420	1360	650	91	2.5 / 3.6
300	1809	1741	586	95	3.6

Solar Tanks with Double-Jacket Heat-Exchanger

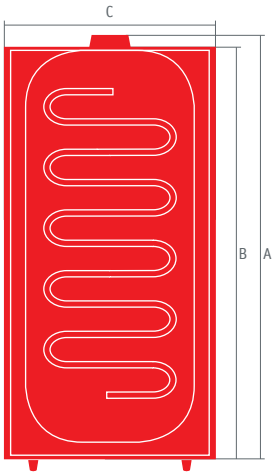


[1] External coating
[2] Insulation
[3] Storage tank
[4] Enamel coating
[5] Electric element
[6] Sacrificial anode
[7] Thermostat
[8] Cold water supply
[9] Hot water from collector - inlet
[10] Hot water to user
[11] Cold water to collector - outlet

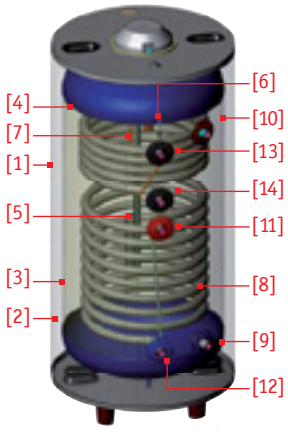


Capacity [L]	A [mm]	B [mm]	C [mm]	Weight [Kg]	Electric Element (kW)	Heat-Exchanger Area [m2]	Heat-Exchanger Vol. [L]
120	1260	1185	477	74	2.5	0.9	7.5
150	1020	950	585	75	2.5	0.8	6.5
200	1270	1210	585	93	2.5	1.2	9.5
300	1420	1360	690	133	2.5/ 3.6	1.6	12.5
300	1814	1741	578	145	2.5	2.0	16

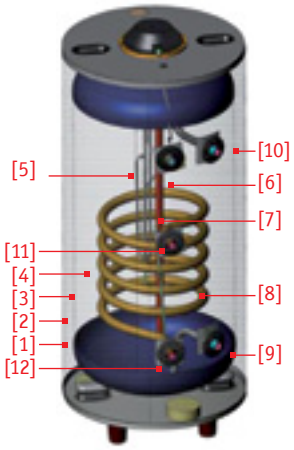
Solar Vertical Tanks with Spiral Heat-exchanger



[1] External coating
[2] Insulation
[3] Storage tank
[4] Enamel coating
[5] Electric element
[6] Sacrificial anode
[7] Thermostat
[8] Spiral heat-exchanger
[9] Cold water inlet
[10] Hot water to user
[11] Heat-exchanger inlet
[12] Heat-exchanger outlet
[13] Auxiliary heating inlet
[14] Auxiliary heating outlet



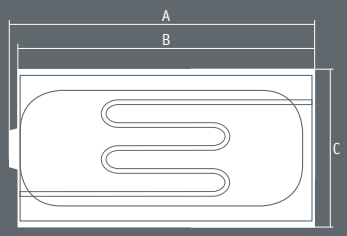
Double Spiral



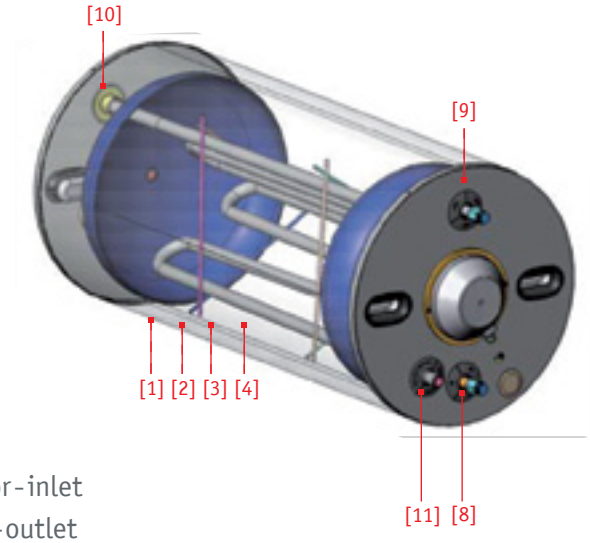
Single Spiral

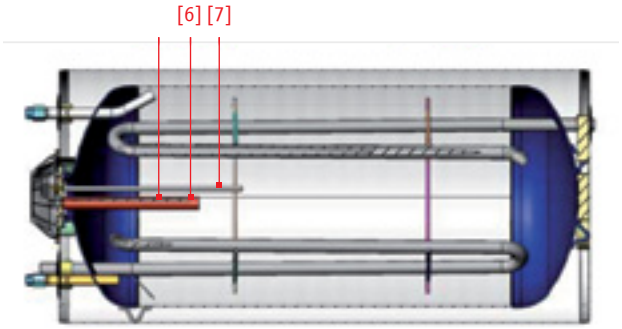
Capacity [L]	A [mm]	B [mm]	C [mm]	Weight [Kg]	Electric Element (kW)	Main HXG. Area [m2]		Main HXG. Vol. [L]	
120	860/ 1260	86/ 1185	585/ 477	74/76	2.5	0.6	0	3.3	0
150	1020/ 1480	950/ 1415	585/ 477	75/78	2.5	0.6	0	3.3	0
200	1270	1210	585	93	2.5	0.6	0	3.3	0
200 Double Spiral	1270	1210	585	108	2.5	0.6	0.6	3.3	3
300	1420	1360	650	133	2.5/ 3.6	0.9	0	5	0
300 Double Spiral	1420	1360	650	145	2.5/ 3.6	1.2	0.6	6.5	3

Horizontal Tank with Serpentine Heat-exchanger



[1] External coating
[2] Insulation
[3] Storage tank
[4] Enamel coating
[5] Electric element
[6] Sacrificial anode
[7] Thermostat
[8] Cold water supply
[9] Hot water to user
[10] Hot water from collector - inlet
[11] Cold water to collector - outlet





Capacity [L]	A [mm]	B [mm]	C [mm]	Weight [Kg]	Electric Element (Watt)	Heat-Exchanger Area [m2]	Heat-Exchanger Vol. [L]
300	1420	1360	650	133	2.5/ 3.6	0.8	4.5

4 Installation: Getting Started

4.1 General Information

[1] Safety Precautions - Read carefully BEFORE installation. This manual contains easy-to-follow instructions for the correct installation, activation and function of Chromagen domestic solar water heating systems.

Please take your time to understand the system and its parts; it will ensure a successful and trouble-free installation. If you have any questions regarding this installation contact your Chromagen agent.

When working on, or around your roof, take care to avoid hazards such as electrical wires and loose shingles/tiles. Use extreme caution when using a ladder or when walking on the roof. Safety always comes first!

[2] The information provided in this manual is general. System installations in different locations might require a different emphasis. Please consult with a Chromagen representative if any doubt arises.

[3] Brass fittings must not be connected directly to the tank pipes to prevent galvanic corrosion. Steel sacrificial adaptor or dielectric fitting must be used.

[4] Lightning protection is based on the connection of the system's metal tubing to common grounding in order to provide the easiest path for lightning to pass to the ground.

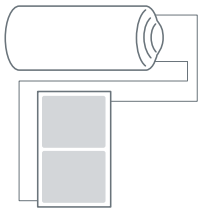
[5] Remember that the system components may be damaged if not handled properly. Take extreme care when loading, unloading, transporting or lifting to the roof.

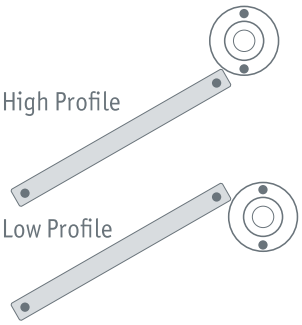
[6] For safety reasons a system shall be provided with blow-off lines wherever steam or hot fluid can escape.

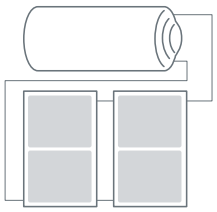
120 L System	150 L System	200 L System	300 L System
Tank: 120 L/32 GL	Tank: 150 L/40 GL	Tank: 200 L/53 GL	Tank: 300 L/80 GL
Collector: 1xD (CR100) [1.85 m^2] Or 1xK (CR90) [1.52 m^2]	Collector: 1xE (CR110) [2.15 m^2] Or 1xD (CR100) [1.85 m^2]	Collector: 1xF (CR120) [2.56 m^2] Or 1xE (CR110) [2.15 m^2]	Collector: 2xE (CR110) [4.3 m^2] Or 2xD (CR100) [3.7 m^2]

4.2 Thermosiphon System Configuration

Storage Tank Vol.	Collector Type
120 L	1×K[CR 90] 1×D[CR 100]
150 L	1×D[CR 100] 1×E[CR 110]
200 L	1×F[CR 120]
300 L	2×D[CR 100] 2×E[CR 110]

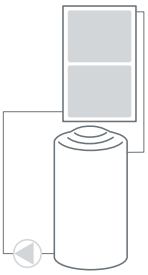


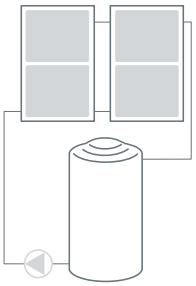




4.3 Forced Circulation System Configuration

Storage Tank Vol.	Storage Tank Type	Collector Type
120 L	D.J. Wide	1×D[CR 100]
	Spiral Narrow/Wide	1×E(CR 110)
150 L	D.J. Wide	1×D[CR 100]
	Spiral Wide	1×E(CR 110)
200 L	D.J. Wide	1×F(CR 120)
	Spiral Wide	
300 L	D.J. Narrow	2×D[CR 100]
	Spiral Narrow	2×E(CR 110)





[·] Different configurations or different absorbers might be needed in different global locations

[·] For accessories, plumbing and mounting parts review chapters 5, 6 and 8

[·] Dimensions, weight and other properties of solar collectors can be found in chapter 2

[·] Dimensions and weight of solar, double jacket and spiral tanks can be found in chapter 3

[·] Supply line recommended pressure: 4-6 bars

[·] Thermostat maximum temperature setting: 60°C (140°F)

4.4 Safety During Site Inspection

[·] Always exercise extreme caution when working on or around a roof
[·] Be sure to secure ladders so that they do not slip or fall
[·] Wear shoes with proper tread to prevent slipping
[·] Disconnect all electric power when installing the control system and pumps
[·] Always consult with the proper authorities or check with your local building department for requirements and applicable codes before starting the job

4.5 Review Local Codes

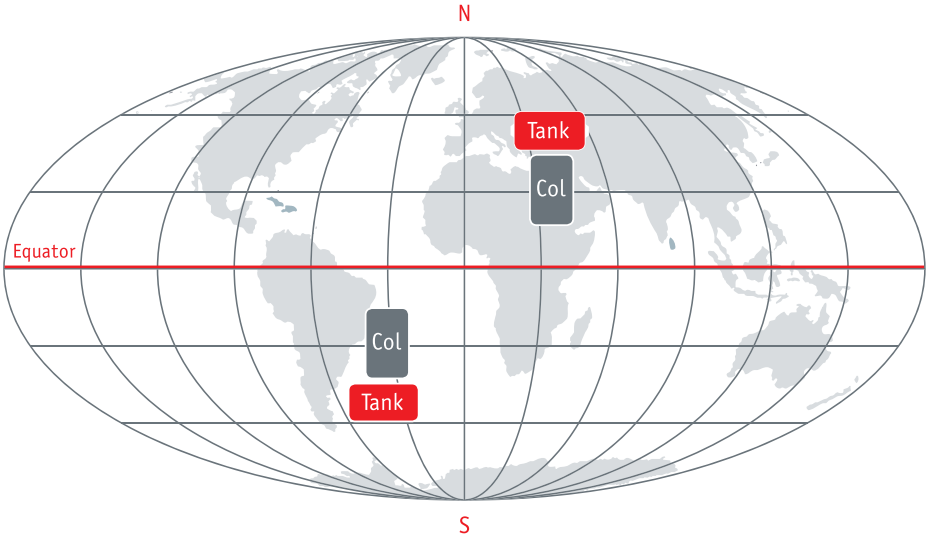
Review:
[a] Area requirements
[b] Plumping requirements
[c] Roof support stress load and modification requirements, (including engineering review, if necessary)

Obtain building plans, if possible, to help locate bearing walls/columns/beams, and determine truss strength.

Record extreme weather conditions:
[a] Heavy snowfall areas require a roof-ridge mount
[b] High-wind areas require an additional bracing kit
[c] Installation sites subject to winds of more that 50 m.p.h. require a specially engineered mounting rack

4.6 Tools and Equipment

Basic Plumbing Supplies	Carpentry Supplies
Standard tools: pliers, cutters, hammers, saw, screwdrivers, metric and American wrenches	5x10x240 cm (2"x4"x96") redwood or treated wood runners as required
12" pipe wrench	Masking/Duct tape
Adjustable - crescent wrenches	Waterproof sealing compounds
Water pressure gauge	M8/5/16" lag bolts , length 2",3",4",6" as required
Copper tubing tools	Nails, 10 cm (16d - 3.5") or assorted as required
Caulking gun	Silicone sealant
24" spirit level	Wood/sheet metal screws and washers
Measuring tape	
Extendable ladder	
½"electric drill with bits	
Skill saw with standard and masonry blades	



4.7 Selecting System Location

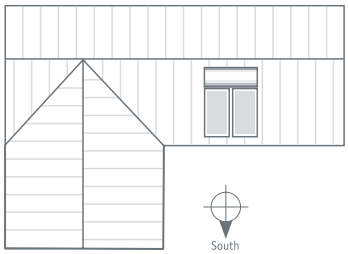


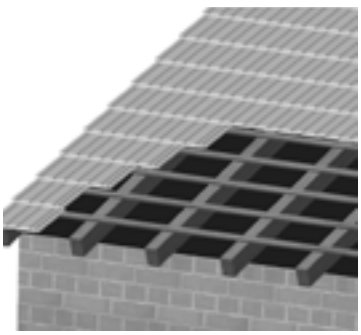
Figure 6.5 Northern Hemisphere Positioning

[·] System must face south when installed in a northern hemisphere location
[·] System must face north when installed in a southern hemisphere location
[·] Deviation of 30^0 to each side is acceptable
[·] Site must be shade-free all year round and clear of obstructions

4.8 Roof Survey

Record the following on your pre-installation survey:
[·] Type of roofing material (tile, shingle, tar & gravel, metal, etc.)
[·] Roof condition. Note repair requirements
Note: Roofs in poor condition may need replacement before installation.

Using the following table, select the appropriate supporting structure:



Tile roof structure

Roof Type	Supporting Structure
Inclined roof	TS system inclined roof rack
	FC system collectors rack
Flat roof	TS system universal flat roof stand
	FC system flat roof collectors rack

[·] Draw diagram (top view) of installation area. Mark the location of the system and stub-out (see figure 6.5)

Installation Tilt-Angle

Flat solar collectors must be tilted at an angle (to the horizontal surface) that is approximately equal in degrees to the local latitude. Since the sun is lower on the horizon during the winter months, tilting the collector at an angle of up to 15 degrees greater than latitude increases winter performance, which is desirable in most cases.

Roof Support Requirements

The 300 L (80 GL) system weighs 475 kg (1140 lbs) when installed and filled, therefore it might be necessary to provide additional roof support. You must inspect the roof support system to determine if additional bracing is needed.

4.9 Water Requirements

Water quality | City water is a controlled water source and should not cause any difficulty with the system. Some water may have elevated mineral content and require more frequent system maintenance. **For additional information review section 1.8.**

Water pressure | Water pressure range of 1 to 6 bars (15-87 psi) is required for a correct operation. Pressure above 6 bars (87 psi) requires the installation of a pressure regulator on the main supply.

Notes:

[·] All plumbing installation must conform to local codes
[·] All piping must be adequately supported: supports must conform to local codes
[·] All piping must be adequately insulated: insulation must conform to local codes
[·] All piping must slope towards a drain
[·] Plumbing must be installed in a manner that minimizes flow resistant

4.10 Customer Approval

Suggested customer procedures:

[·] Review installation point with the customer
[·] Ensure that the customer signs job approval form

4.11 Work Force

The empty 300 L (80 GL) tank weighs 130 kg (290 lbs) and special provisions are required to lift it to the roof. In some cases a crane is needed to place the tank on its rack. Only a qualified electrician, should install all electrical wiring. **Professional installation is essential to the reliable operation of a solar system.** Installers should be specialists in the planning and installation of solar water heating systems.

4.12 Propylene Glycol Properties

For anti-freeze protection of closed-loop solar systems anti-freeze liquid is filled, containing a certain percentage of propylene glycol solution according to the lowest ambient temperature predicted.

Concentration by Volume	Propylene Glycol Freezing Point
55%	-40°C (-40°F)
50%	-33°C (-28°F)
40%	-25°C (-13°F)
30%	-16°C (+4°F)
20%	-8°C (+17°F)

Notes:

[·] Concentration of 40% to 50% glycol is accepted as a standard in central Europe

[·] Anti-freeze protection is essential, as a single freeze event can destroy a collector. (Even in warm areas, collector tubes have frozen and burst during hard winter freezes)

[·] The Food and Drug Administration (FDA) has determined propylene glycol to be "generally recognized as safe" for use in food, cosmetics, and medicines

[·] Corrosion is usually minimized by using pH control and corrosion inhibitor use; however corrosion problem are unlikely to occur in air-free closed circuit systems

5 

Thermosiphon System Installation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5.1 Inclined Roof Installation

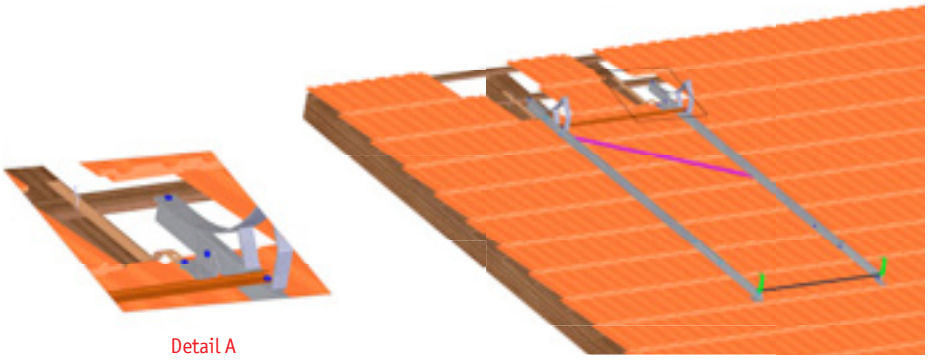
[1] Mark supporting rafter/truss and bearing-wall/column/beam locations on roof
[2] Mark the tank location on the roof
[3] Remove the tiles and place four metal bases on the roof truss with 8×60 M lag bolts
[4] Place the tiles back in place and seal holes, if any were made
[5] Place the system metal frame over the bases and secure the frame to the bases with 10 M bolts
[6] Position and secure the tank to the cradle to the cradle, **remember that the tank is heavy and needs special care**
[7] Position the collectors in place and secure them by using the supplied brackets
[8] Connect the solar collectors between them (if two or more are used), using a ¾" brass union
[9] Connect the flexible pipes between the tank and the collectors to ensure continuous slope toward the tank
[10] Fill the water tank with water and make sure there is no leakage
[11] Fill the closed-loop with anti-freeze, purge air and make sure there is no leakage

Inclined Roof Rack Parts

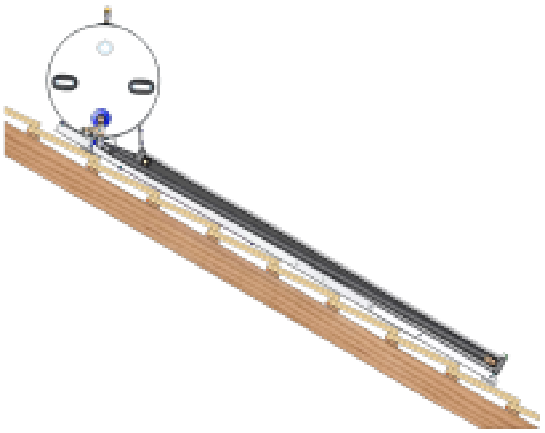
TS 150/200 L Inclined Roof Stand Parts		
No.	**Description**	**Quantity**
MXMAMZV100	Front leg TLSCPc 1	2
MXMAMZV105	Front leg TLSCPc 2	2
MXMAMZV155	Upper bar 200	1
MXMAMZV150	Collector ruler 200	1
MXMAMZV120A	Tank support 1	2
MXMAMZV120B	Tank support 2	2
MXMAMZV122	COL. securer 45°	2
MXMAMZV145	Tension bar-diag 200	1
MXMAMZV100	Leg base	4
	Bolt 8x15 M	18
	Nut 8 M	16
	Bolt DIN 7991 8x20 M	2

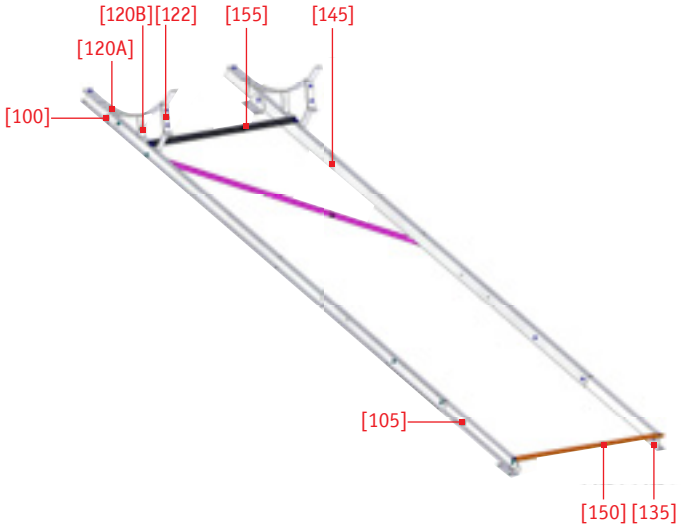
TS150/200 L Inclined Roof Stand Parts

Install the system rack as shown in the drawings:



[·] Use a mold to set the location of the bases in accurate position

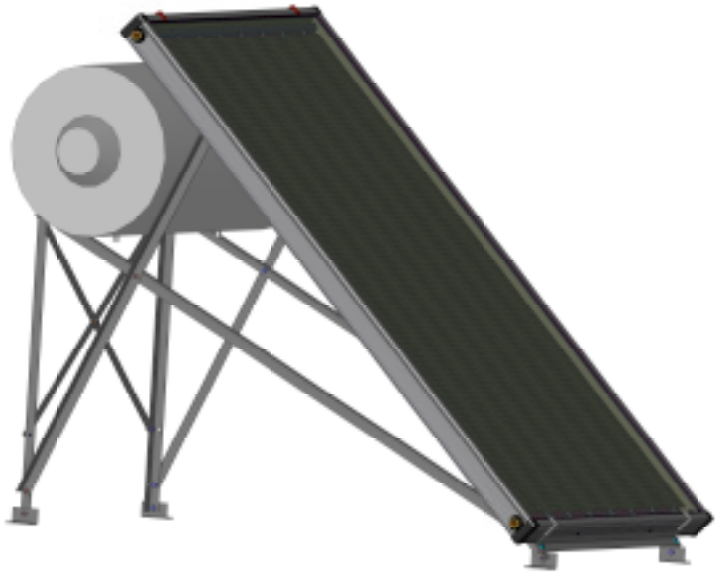




5.2 Flat Roof Installation

Flat Roof Stand

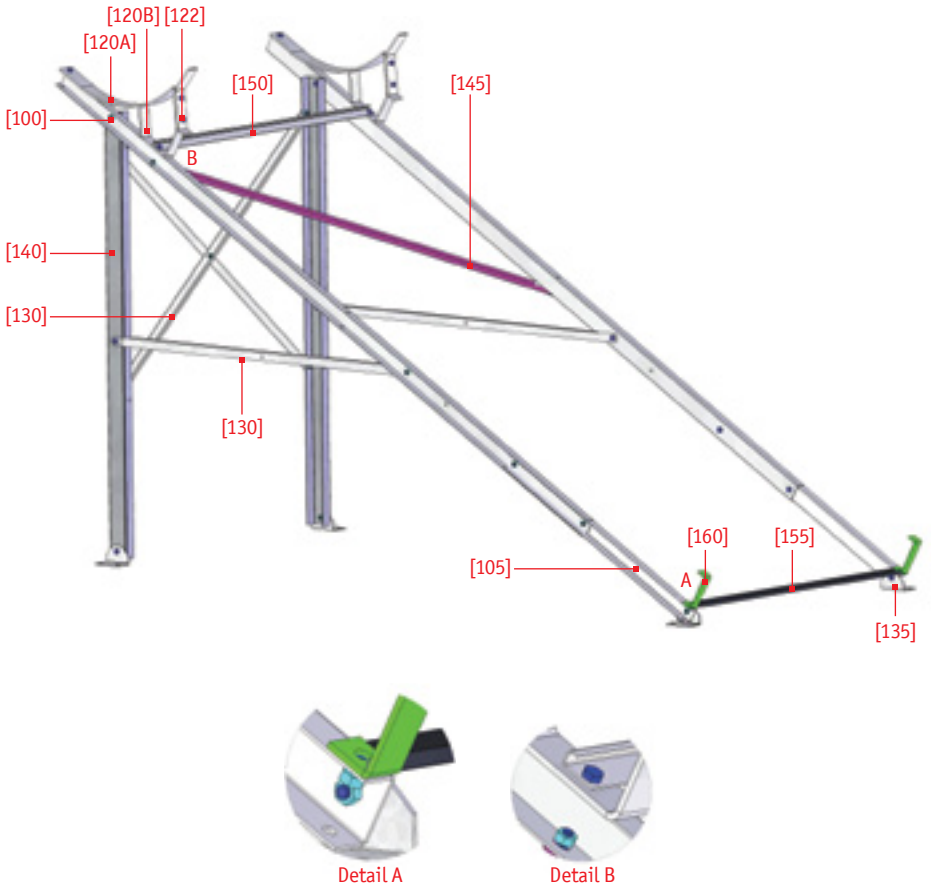
[1] Mark supporting rafter/ truss and bearing-wall/column/beam locations on roof
[2] Mount and position the stand on provisions made for the stand in the flat roof
[3] Position and secure the tank on the cradle, **remember that the tank is heavy and needs special care**
[4] Position the collectors on the stand and secure them by using the supplied brackets
[5] Connect the solar collectors between them (if two or more are used), using a ¾" brass union
[6] Connect the flexible pipes between the tank and the collectors to ensure continuous slope toward the tank
[7] Fill the water tank with water and make sure there is no leakage
[8] Fill the closed-loop with anti-freeze purge air and make sure there is no leakage



Low Profile Installation

Parts for 150 L & 200 L Stands 30° & 45° Mounting:

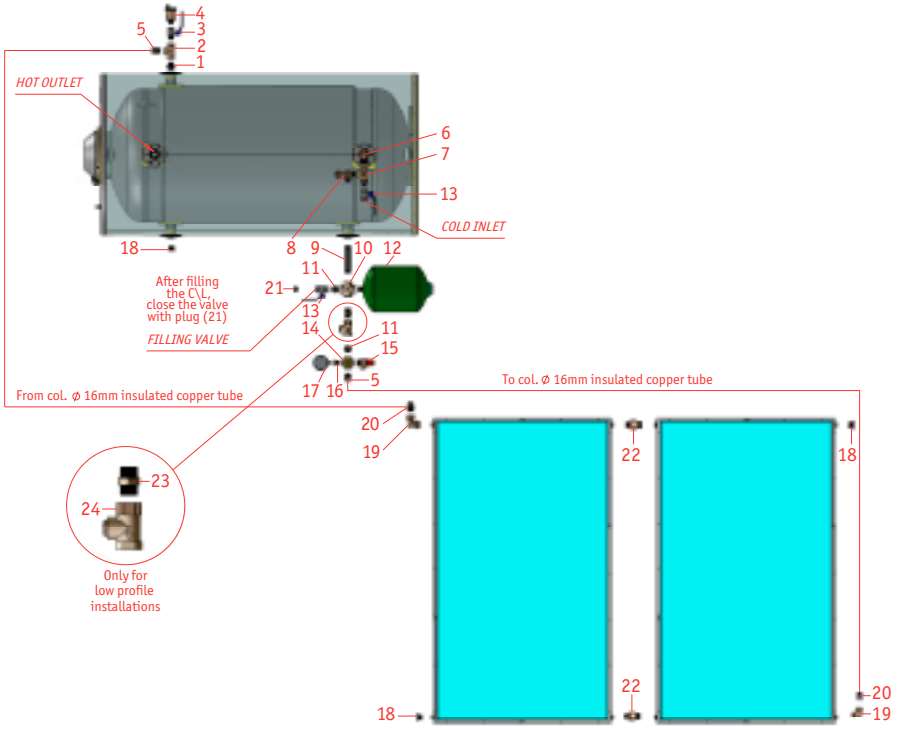
Part No.	Description	MAXFH1F30 200L-30° QTY.	MAXFH1F45 200L-45° QTY.	MAXFH1D30 150L-30° QTY.	MAXFH1D45 150L-45° QTY.
MXMAMZV100	Front leg TLSCPc 1	2	2	2	2
MXMAMZV105	Front leg TLSCPc 2	2	2	2	2
MXMAMZV110	Upper bar 150	0	0	1	1
MXMAMZV115	Collector ruler 150	0	0	1	1
MXMAMZV120A	& MXMAMZV120B	2	2	2	2
MXMAMZV122	COL. securer 45°	2	2	2	2
MXMAMZV125	Rear leg 150-30	0	0	2	0
MXMAMZV126	Rear leg 150-45	0	0	0	2
MXMAMZV130	Tension bar	4	2	5	3
MXMAMZV131	Tension bar short	0	2	0	2
MXMAMZV135	Leg base	4	4	4	4
MXMAMZV140	Rear leg 200 30°	2	0	0	0
MXMAMZV141	Rear leg 200 45°	0	2	0	0
MXMAMZV145	Tension bar-diag. 200	1	1	0	0
MXMAMZV150	Collector ruler 200	1	1	0	0
MXMAMZV155	Upper bar 200	1	1	0	0
MXMAMZV160	Steel frame COL. securer	2	2	2	2



[·] For detailed drawings of other models such as low profile stands, please contact your local Chromagen agent

5.3 Plumbing

Use the fittings and accessories supplied with the system. Install the system according to one of the following installations possibilities:



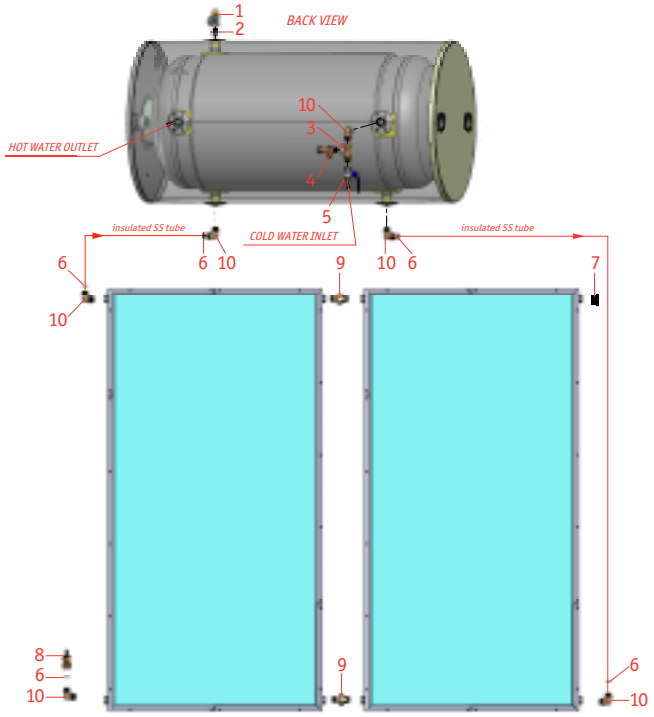
[·] In a high profile installation there is no need for a "low profile check valve" since there is no risk of reverse thermosiphon action

No.	Description Thermosiphon Closed loop system	IKITCL0190 QTY.	IKITCL0200 QTY.
1	Steel reducing nipple 1/2" - 3/4"	1	1
2	Brass T 1/2"	1	1
3	Ball valve 1/2" M-F	1	1
4	Air relief valve 1/2"	1	1
5	Brass copper tube 1/2" M-16 mm	2	2
6	Brass elbow 3/4" M-M	1	1
7	Brass check valve 1/2"-3/4"	1	1
8	Brass pressure relief valve 8 bar 1/2"	1	1
9	Galvanized nipple 3/4"x120	1	1
10	Brass cross 3/4"	1	1
11	Brass reducing nipple 3/4"-1/2"	2	2
12	Expansion vessel 8 L	1	1
13	Brass ball valve F-F 1/2"	2	2
14	Brass cross 1/2"	1	1
15	Pressure relief valve 3 bar	1	1
17	Manometer	1	1
18	Brass plug 3/4" M	3	3
19	Brass street elbow 3/4" F-M	2	2
20	Brass copper tube 3/4" M-16 mm	2	2
21	Brass plug 1/2" M	1	1
22	Brass bushing 1/4"-1/2"	1	1
22	Brass union 3/4"	2	-
23	Brass hex double nipple 3/4"	1	1
23*	Brass hex double nipple 3/4"	1	1
24*	Low profile valve 3/4" F-F	1	1

[·] (23,24) Only for low profile installations ·IKITCL0190 kit for 2 collectors ··IKITCL0200 kit for 1 collectors

[·] for safety reasons a system shall be provided with blow-off lines wherever steam or hot fluid can escape (parts 8,15)

Thermosiphon Closed-Loop System

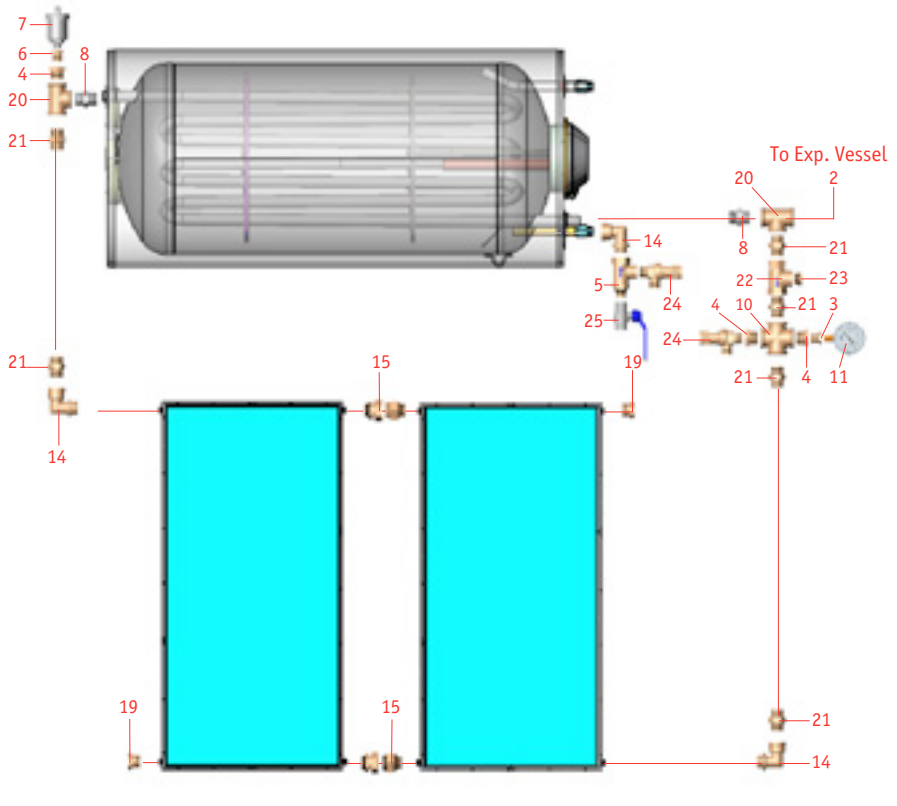


[·] High profile installation

No.	Description Thermosiphon closed-loop system	IKITCL0330 QTY.	IKITCL0360 QTY.
9	Brass union 3/4"	-	2
10	Brass street elbow 3/4"	6	6
2	Brass reduction nipple 1/2"-3/4"	1	1
3	Brass check valve 1/2"-3/4"	1	1
4	Brass pressure relief valve 8 bar	1	1
5	Brass ball valve 1/2" F-F	1	1
1	Safety valve 3 bar 1/2"x3/4"	1	1
8	Ball valve	1	1
7	Brass plug 3/4" M	1	1
6	Flat fiber seal 3/4"	5	5

· IKITCL0330 kit for 1 collectors ·· IKITCL0360 kit for 2 collectors

[·] For safety reasons a system shall be provided with blow-off lines wherever steam or hot fluid can escape (parts 1,4)



[·] In a high profile installation there is no need for a "Low Profile check valve" since there is no risk of reverse thermosiphon action

No.	Description	Qty.
2	Expansion vessel 8 L	1
3	Brass bushing 1/4"-1/2"	1
4	Brass bushing 1/2" x 3/4"	3
5	Brass check valve 1/2"-3/4"	1
6	Brass bushing 3/8"-1/2"	1
7	Automatic air relief valve	1
8	Galvanized nipple 3/4"	2
10	Brass cross 3/4"	1
11	Manometer	1
14	Brass street elbow 3/4" M-F	3
15	Brass union 3/4" M-M	2
19	Brass plug 3/4" M	2
20	Brass T 3/4"	2
21	Brass hex double nipple 3/4"	6
22	Low profile valve 3/4" F-F	1
23	Brass plug 1/2"	1
24	Brass pressure relief valve 8 bar	2
25	Brass ball valve 1/2" F-F	1

[·] For safety reasons a system shall be provided with blow-off lines wherever steam or hot fluid can escape (parts 24 x two units)

5.4 Filling and Testing

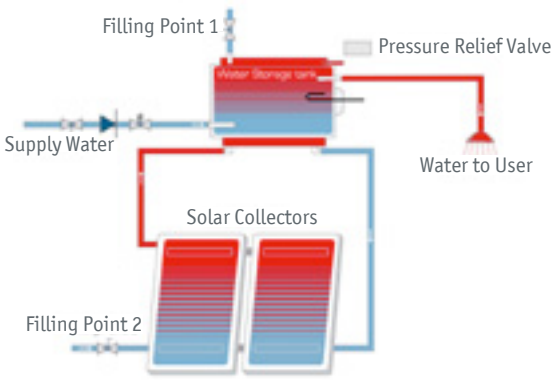
Important: in a double-jacket tank, ensure that the solar storage tank is filled and pressurized before filling the double mantle.

Filling Procedure

[1] Make sure that all system connections are fastened and that the tank is leveled
[2] Connect the tank to the main water supply and fill with potable water
[3] Remove heat-exchanger air relief valve
[4] Connect the anti-freeze filling pipe to the filling valve
[5] Fill the closed-loop with anti-freeze solution until all the air is purged out of the collector loop and it is completely filled
[6] Return to place the air relief valve
[7] Pressurize the closed loop to 3 bar and make sure all the air is purged
[8] Test for possible leaks and repair, if needed
[9] Lower the collector loop pressure to a working pressure of 2-3 bars by purging water from the air relief valve

Additional Notes

[·] Prepare 10-20 L of anti-freeze solution depending on the heat-exchanger type and size. (See anti-freeze solution table in section 4.12 | See collector volume in chapter 2 | See heat-exchanger volume in chapter 3)
[·] The system operates properly only when the internal heat-exchanger is fully filled with liquid. Air in the system might hinder the thermosiphon action. Check carefully for leaks and tighten all fittings (re-checking is recommended every 6 months)
[·] Recommended closed loop working pressure is 2 - bar for Double-Jacket and 3 bars for spiral heat-exchanger
[·] It is necessary to install a pressure reduction valve if the water supply pressure exceeds 6 bars
[·] There is no provision for the collection of water in case of leakage from the tank. (Seal or fitting failure). Consider installing a pile with draining pipe under the tank
[·] Local codes might require the installation of a tempering (mixing) valve between the hot water outlet of the tank and the main hot water supply pipe to the house. The tempering valve should be regulated to 50°C
[·] For safety reasons a system shall be provided with blow-off lines wherever steam or hot fluid can escape

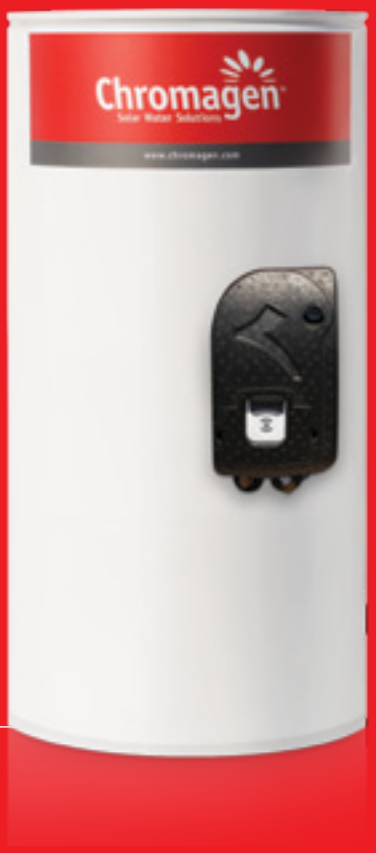


[·] Tank must be located above the collectors

[·] Low profile requires additional check valve

6

Forced Circulation System Installation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6.1 Introduction

Forced circulation systems are to be used whenever the storage tank cannot be installed above the collectors as described in chapter 2. The circulating pump is operated by a differential thermostatic control. The basic elements of this system are:

[·] Solar collectors
[·] Storage tank
[·] Circulation pump
[·] Differential thermostat
[·] Sensors
[·] Expansion tank
[·] Valves and accessories

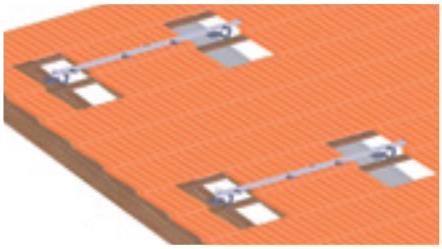
The elements in this system simulate the thermosiphon phenomena.

No.	Description Inclined Roof Rack for 2 Collectors	MXFH0030 QTY.
1	ALUM sima30 profile 2310 mm	2
2	Carriage bolt 8 M	20
3	8 galvanized nut M	20
4	Collector fastener alum	8
5	Rack base	4
6	Collector support 99 x 30 x 2	4
7	Lag bolt 8 x 60 M	12

6.2 Inclined Roof Installation

[1] Screw 2 pairs of bases to the roof base beams

[2] Connect 2 aluminium bars to the 2 upper and 2 lower bases

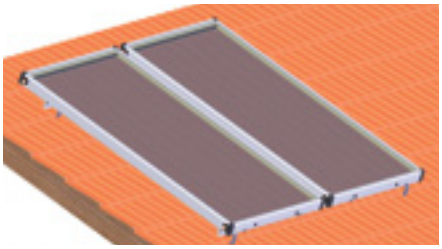


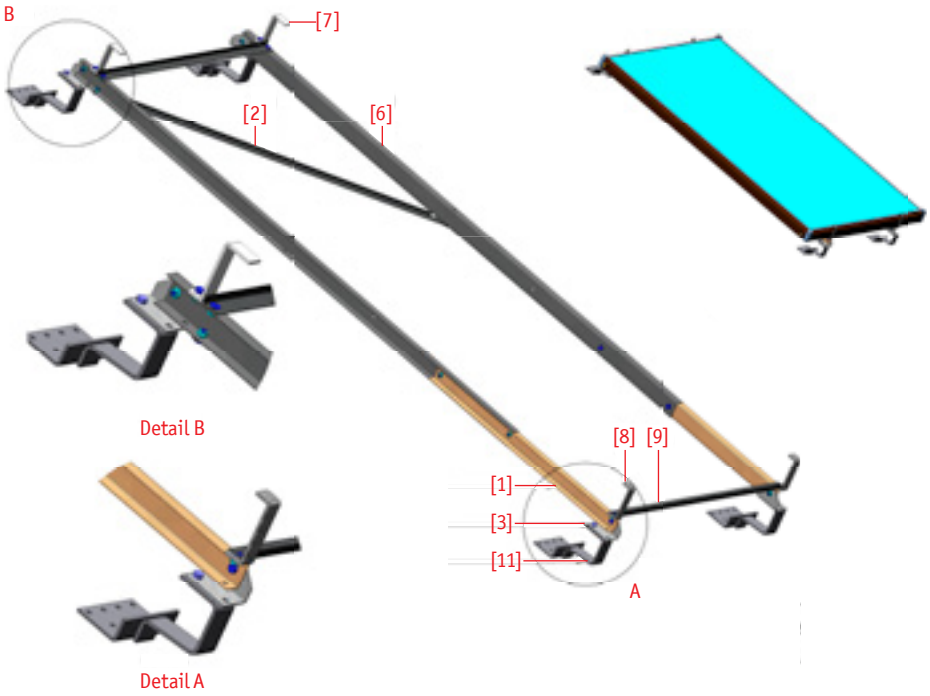
Place the collectors over the 2 bars

[3]

[4] Secure the collectors to the bars

[5]





Single Collector Steel Rack

No.	Part number	Description	MXFH0030 QTY.
1	MXMAMZV105	Front leg TLSCPc 2	2
2	MXMAMZV130	Tension bar	1
3	MXMAMZV135	Leg base	4
4	PBRAGV060	Nut 8 M	16
5	PBRAGV040	Bolt 8x15 M	12
6	MXMAMZV240	Front leg TLSCPc 1	2
7	MXMAMZV225 - a	Collector upper securer	2
8	MXMAMZV200	Collector bottom clamp	2
9	MXMAMZV110	Lower/upper bar 150	2
10	PBRALN100	DIN 7991 8x20 M conic head	4
11	MXMAMD020	Slope roof stand base	4
12	PBRAGV030	Hex bolt 10x20 M	4
13	PBRAGV065	Hex nut 10 M	4

6.3 Flat Roof Installation

[·] Wind pressure requires binding the collector to the roof

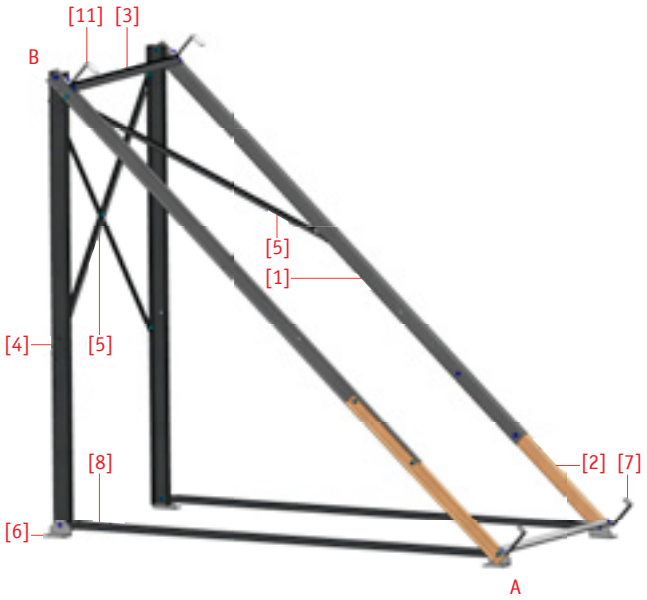
[·] The wind pressure can be approximated by:
Pressure = ½ x (density of air) x (wind speed)^2 x (shape factor)

[·] The density of air is about 1.25 kg/m^3. The shape factor (drag coefficient) depends on the shape of the body. It has order of magnitude 1 and it is dimensionless; here it is approximated as 0.6

[·] The wind speed must be expressed in m/s. In that case the pressure has units of kg/m/s^2, i.e. N/m^2

[·] In case of 40 m/s wind speed=> wind pressure=0.5x1.25x40x0.6=600 [N/m^2]=600 [pa]

[·] This pressure requires a support of approximately 60 kg for every square meter mounted in a 45° on a flat roof



Detail A

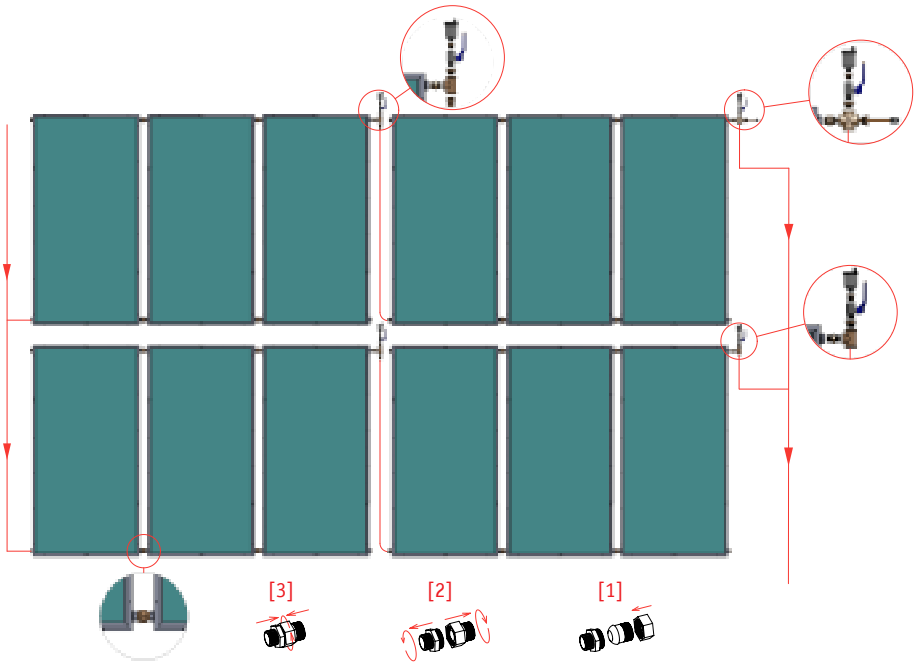
Detail B

4x8 M Concrete Wedge Anchors
[Optional method of securing the stand to the roof]

No.	Description Flat Roof Collectors Stand 1xE/F	MAXFHEF45 QTY.
1	Front leg TLSCPc 1	2
2	Front leg TLSCPc 2	2
3	Lower/Upper bar	2
4	Rear leg	2
5	Tension bar	3
6	Leg base	4
7	Collector bottom clamp	2
8	Long tension bar	2
9	NUT 8 M	23
10	Bolt 8 x 15 M	19
11	Collector upper securer	2
12	Cone bolt and nut 8 x 20 M	4

6.4 Installation of Collectors Field

Large forced circulation systems requires larger collectors field

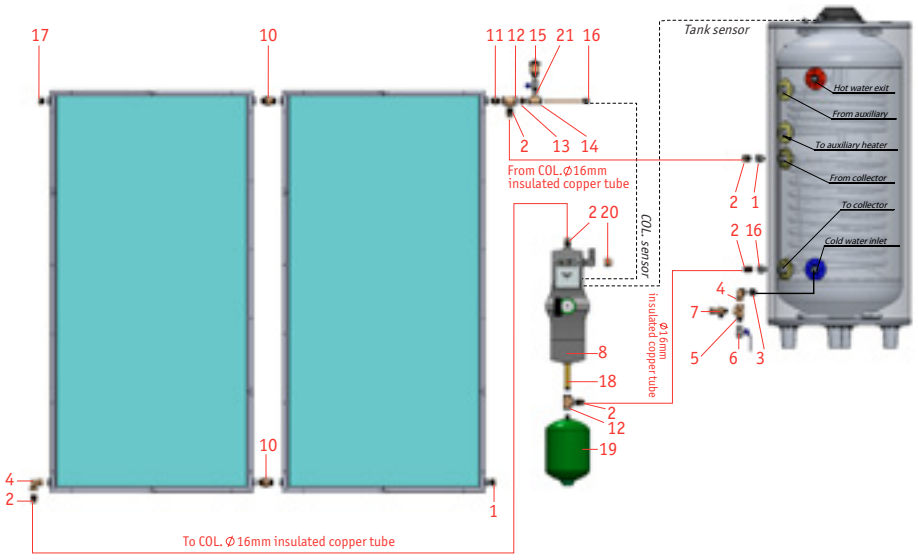


The collectors are regularly connected to each other with 3/4" brass unions

6.5 Location of Collectors, Tank and System Operation

The collectors should be placed facing south or north, depending on the earth's latitude and slope, as explained in section 4.7. The tank should be placed as close as possible to the collectors, to avoid heat loss . The recommended pump should match the hot water circulation and a flow of 50-100 L per hour per 1 m^2 of collectors' area.

Plumbing Forced Circulation System



No.	Description Forced System with Pump Station	IKITCL0168 QTY.
1	Steel adaptor 3/4" M-F	2
2	Brass copper tube 3/4" M-16 mm	6
3	Steel short nipple 3/4"	1
4	Brass street elbow 3/4"	2
5	Brass check valve 1/2-3/4"	1
6	Brass ball valve 1/2" F-F	1
7	Brass pressure relief valve 8 bar	1
8	Pump station	1
10	Brass union 3/4"	2
11	Brass hex double nipple 3/4"	1
12	Brass 3/4" T	2
13	Brass reduction nipple 1/2-3/4"	1
14	Brass 1/2" T	1
15	Air relief valve	1
16	Temperature sensor 20 cm sensor	1
17	Brass plug 3/4" M	2
18	Brass barrel nipple 3/4"	1
19	Expansion vessel 8 L	1
20	Brass plug 3/4" F	1
21	Ball valve 1/2" M-F	1

[·] For safety reasons a system shall be provided with blow-off lines wherever steam or hot fluid can escape

6.6 Anti-freeze Protection

The system is double anti-freeze protected. The heat transfer liquid is a solution of propylene glycol and water, and the pump circulates warmer heat transfer liquid through the collector in freezing conditions. Anti-freeze protection is essential for all solar systems as a single freeze can destroy a collector.

6.7 Plumbing

Follow the installations details as shown on Fig 6.4 and as explained in section 5.4. Use the following guidelines:

- [·] Water feed to the tank should be through a ball valve and a check valve
- [·] Pump must be installed on the cold line, which runs between the lower part of the tank to the lower inlet of the collector(s) and a check valve must be installed next to the pump
- [·] To allow pump service, install ball valves before and after the pump
- [·] All pipes in the circulation line should be 16/18 mm copper, water-quality pipes
- [·] Pipes lengths shall be adjusted to the specific installation. Shortest pipes should be used to minimize unwanted heat loss
- [·] Best performance achieved with well insulated pipes. The hot line from the collectors must be insulated
- [·] For safety reasons a system shall be provided with blow-off lines wherever steam or hot fluid can escape

6.8 Electrical Connections

It is recommended to put the differential thermostat in an electrical box with a switch and fuses. The box should be accessible for maintenance and easy to operate. A qualified electrician should perform all wiring according to local codes. The wiring from the differential thermostat to the sensors carries a very low voltage and is not dangerous when wired correctly.

6.9 Additional Notes

- [·] A discharge pipe may be connected in a continuously downward direction in a frost free environment and open to the atmosphere
- [·] It is necessary to install a pressure reducing valve, if the water supply pressure exceeds the rated pressure
- [·] The recommended flow rate of the collector loop is 50-100 l/hr m2 of absorber surface

7 Troubleshooting and Maintenance

7.1 Thermosiphon System Troubleshooting

Problem	Probable Cause	Corrective Action
Not enough hot water	[1] Shadow on the collectors	[1] Remove obstruction
	[2] Incorrect piping	[2] Re-pipe
	[3] Clogging pipes	[3] Clean pipes
	[4] Tank blocked with sediment	[4] Clean
	[5] System not leveled	[5] Level
	[6] Ruptured tank jacket	[6] Replace tank
	[7] Air trapped in circulation pipes	[7] Purge air
	[8] Not enough liquid in the closed loop	[8] Fix leaks and fill up

7.2 Forced Circulation Systems Troubleshooting

Problem	Probable Cause	Corrective Action
Pump is not working	[1] Electrical fault	[1] Check electrical connections
	[2] Burnt motor or fuses	[2] Replace
	[3] Cloudy weather, not enough temperature to operate thermostat	[3] No action required. The system is working
	[4] Differential thermostat is not working	[4] Repair or replace
	[5] Faulty sensor	[5] Replace
Pump working incorrectly	[1] Working non-stop	[1] Check differential thermostat
	[2] Air trap	[2] Purge air
	[3] Faulty sensors	[3] Replace
	[4] Differential thermostat does not begin to work.	[4] Repair or replace thermostat
No water circulation	[1] Water taps in circulation line are closed	[1] Open
	[2] Air trapped in circulation loop	[2] Purge air
	[3] Blockage in circulation loop piping	[3] Clear blockage
	[4] Piping diameter too small causing high pressure drop	[4] Replace with wider diameter piping
No hot water	[1] Pump is not operating	Check all accessories, air vents, one way valves, filling system of jacket
	[2] Air trapped in circulation loop	
	[3] Frozen or leaking pipes	
	[4] Pump circulates during cloudy days or night due to faulty sensors	
Circulation Pump operating non-stop	[1] Control switch in manual position	[1] Set switch to automatic position
	[2] Air trapped in solar circulation loop	[2] Release air via air vent valves installed in collectors array
	[3] Defective differential thermostat	[3] Check the differential thermostat. Replace if necessary
	[4] Faulty sensor(s)	[4] Check sensor(s) with Ohmmeter. Replace if necessary

WARNING! These systems are electrically powered. Take necessary precautions to avoid electrical shock.

Problem	Probable Cause	Corrective Action
Pump operating at night or when there is lack of solar radiation during the day due to cloudiness	[1] Control switch in manual position	[1] Set control switch to automatic mode
	[2] Water not circulating in the solar circulation loop	[2] See next section
	[3] Check valve is stuck in open position causing thermosiphon flow in circulation loop	[3] Strike check valve lightly with a plastic hammer or wooden rod
	[4] Defective differential thermostat	[4] Repair or replace
Pump operating but water does not circulate in the circulation loop	[1] Water taps in circulation loop are closed	[1] Open water taps
	[2] Air trapped in circulation loop	[2] Purge air
	[3] Check valve is stuck in closed position	[3] Strike valve with plastic hammer or wooden rod
	[4] Check valve installed in the wrong direction	[4] Install valve in proper flow direction
	[5] Incorrect piping installation in circulation loop	[5] Install piping correctly
	[6] Circulation loop pipe clogging	[6] Locate blockage and clean or replace pipe
	[7] Bent or dented pipes	[7] Replace damaged section of pipe
	[8] Main pipe with too small diameter causes high pressure drop	[8] Use larger pipe diameter
Circulation pump does not operate	[1] Control switch in OFF position	[1] Set control switch to Automatic
	[2] Burnt fuse	[2] Check if fuse is suitable for pump power, Change fuse, check that pump shaft is not stuck
	[3] Defective differential thermostat	[3] Repair or replace
	[4] Faulty temperature sensors	[4] Check sensors with ohmmeter. Replace if necessary
	[5] Faulty pump motor	[5] Replace pump motor
	[6] Pump receiving no power supply	[6] Check if voltage supply is reaching pump connections
	[7] Burnt transformer in the differential thermostat	[7] Change differential thermostat. Check that the voltage supply is not more than 110 V ± 20V
	[8] Collectors are covered with dust	[8] Wash the collectors
Pump operating with long delay	[1] Collector's temperature sensor is installed outside the collector's header	[1] Install sensor as deep as possible inside the collector header
	[2] Tank's temperature sensor is installed too high in the tank	[2] Install the sensor at the bottom of the tank
	[3] Wrong controller setting	[3] Consult with Chromagen technical staff
Pump repeatedly starts and stops	[1] Air-bound system	[1] Purge air out of system-ensure pipes slope
No circulation	[1] Air bound pump	[1] Purge air out of system
	[2] Broken pump coupler	[2] Replace; check alignment
	[3] Clogged impeller or piping	[3] Locate and remove obstruction
	[4] System valve closed	[4] Open
	[5] Incorrect pump electrical-circuit	[5] Check all related low and line voltage circuits

Problem	Probable Cause	Corrective Action
Inadequate Circulation	[1] Air-bound system	[1] purge air out of system- ensure pipes slope
	[2] Air-bound pump	[2] purge air out of system
	[3] Clogged impeller or piping	[3] Locate and remove obstruction
	[4] Clogged strainer	[4] Remove and clean screen
	[5] Pump impeller damaged or backwards	[5] Replace or re-assemble
	[6] Insufficient NPSH	[6] Lower pump, raise pressure or relocate
	[7] Pump too small	[7] Replace pump
	[8] Partially air-bound pump	[8] Purge air out of system
	[9] Pump running backwards (three-phase)	[9] Reverse any two motor leads
	[10] Improper motor speed	[10] Check wiring and voltage
Pump or system noise	[1] Trapped air	[1] Vent system
	[2] Pump cavitation	[2] Lower pump or raise pressure or relocate
	[3] Excessive water velocity	[3] Install balancing cocks or parallel piping
	[4] Poor foundation	[4] Provide rigid foundation with adequate grouting
	[5] Pipe vibration	[5] Provide adequate pipe support or change pipe length
Premature failure of pump components	[1] Improper pump (size/type)	[1] Replace
	[2] Improper pump location	[2] Relocate
	[3] Excessive water treatment	[3] Check manufacturers instructions
	[4] Pump operating close to or beyond	[4] Balance system
	[5] Excessive piping load	[5] Provide proper pipe support

If troubleshooting fails, please contact your local dealer or Chromagen's head office

7.3 Maintenance

This section covers scheduled inspections, maintenance, and detailed procedures for dismantling and repair of the system. Only qualified personnel should perform periodic maintenance.

7.4 Periodic Maintenance

- [·] Check the system pressure every 6 months. Pressure reduction might indicate a leak. The pressure should remain above 1 bar. If necessary, pressurize again and check for leaks
- [·] Every 3-6 months clean the collectors' glazing and trim any surrounding trees that might cast a shadow on the collectors
- [·] Every 12 months flush all safety valves. Pressure relief device failure may result in excessive pressure and system damage. Continuous leakage from the valve may indicate excessive heat or defective valve
- [·] Flush and refill collectors in open-loop systems every 12 - 18 months
- [·] Drain tank if necessary: the cold water inlet is generally the lowest pipe in the tank. Close the main supply, disconnect pipe, and open the tanks' hot water outlet for air to come in while draining
- [·] Replace anodes and safety valves every 3 years
- [·] Every three to five years qualified personnel must check electrical connections (pumps, thermostats, switches and wiring)
- [·] Every three to five years replace anti-freeze

7.5 Parts Replacement

When replacing parts, which are supplied by Chromagen: for example, collector glass, complete collector, tank flange etc., always use Chromagen original parts in order to keep the warranty valid.

7.6 Warnings

A thermal cut-out might indicate a dangerous situation. Do not reset the "Bipolar Safety" of the thermostat until the water heater has been serviced by a qualified person.

WARNING! If the hot water system is not used for two weeks or more, a quantity of hydrogen gas, which is highly flammable, may accumulate in the water heater. To dissipate this gas safely, it is recommended that a hot tap be turned on for several minutes at a sink, basin or bath, but not at a dishwasher, clothes washer or other appliance. During this procedure, there must be no smoking, open flame or any electrical appliance operating nearby. If hydrogen is discharged through the tap, it will probably make an unusual sound like escaping air. For safety reasons a system shall be provided with blow-off lines wherever steam or hot fluid can escape.

8 Accessories

8.1 Solar Station

In a closed-loop installation a pump and thermostatic control are required. These accessories may be installed separately or combined in a complete kit referred to as a SOLAR STATION. Chromagen supplies solar stations, which include the RESOL thermostatic control and a WILO pump.

The standard two-line solar pump station, for integration of the controller RESOL DeltaSol® BS is on the left side of this page (with and without cover). The most important hydraulic components for the operation of a solar system are already mounted for an easy and quick installation:

[·] Controller DeltaSol® BS
[·] Solar thermal pump WILO Star ST20/4 or ST20/6 or ST20/7
[·] Pointer thermometers for feed flow and return flow
[·] Return flow line with ball valve and adjustable non-return valve
[·] Flowmeter with scale
[·] Security bracket with security valve and manometer
[·] KFE-cock for filling and flushing of the system
[·] Wall mounting with screws and dowels
[·] Heat insulation

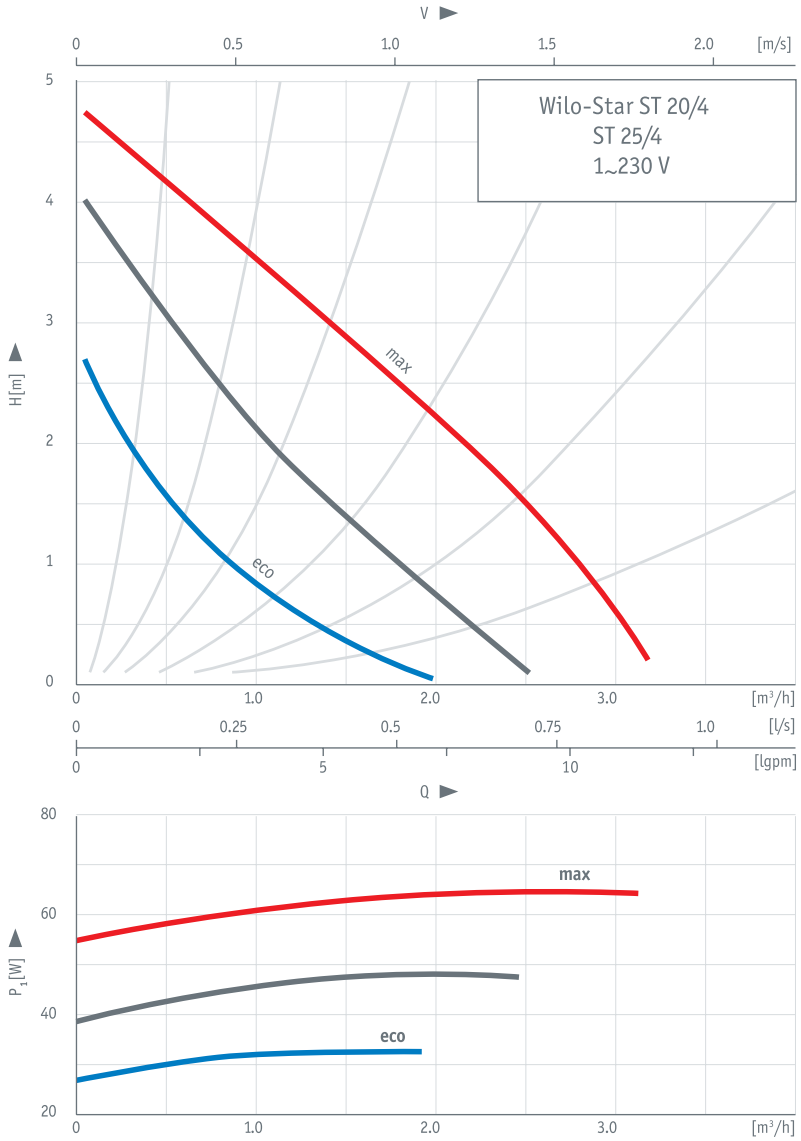
8.2 Thermostatic Control

RESOL | Chromagen supplies solar systems which includes RESOL DeltaSol BS thermostatic control. English, Italian, French and Dutch versions of RESOL Thermostatic control manual can be found in RESOL website: http://www.resol.de/

STECA | Chromagen tested and approved the use of STECA thermostatic control http://www.stecasolar.com/ The English manual version can downloaded from steca web site.

8.3 Circulation Pumps

Example | Pump Performance Chart



[·] A Forced circulation system uses a pump to move hot water or propylene glycol from the collector down to the tank

[·] The water or glycol circulation through the collectors can reach temperatures as high as 130°C, therefore only pumps that are designed to operate with hot water may be used

[·] Selecting a pump is based on the calculated head loss of the collectors loop measured in meters of water and the required flow rate. A nominal flow rate of 50 L/hr per square meter of collectors aperture area may be taken

[·] **For example**, a system with two Chromagen CR110 collectors with aperture area of 2.15 m^2, each one requiring a flow rate of 4.3x50=215 L/hr. the losses over the collectors may be taken as 2x7=14 cm and the losses through 20 m of 16 mm copper tube at 250 L/hr is approximately 60 cm. Taking into account the loss over an internal heat-exchanger and the minor losses over the plumbing accessories, we can assume 1 m head loss over the collectors loop a Wilo star ST20/4 at its lowest speed should easily generate the required flow rate for this system, see the above pump performance chart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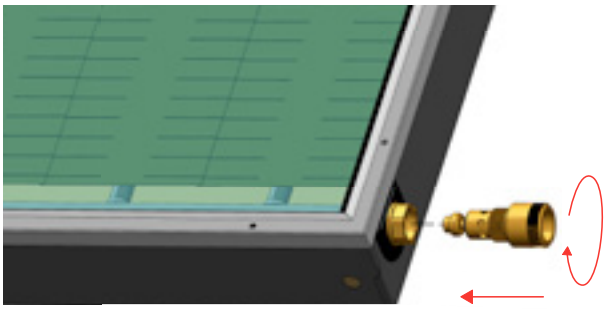
8.4 Freeze Protection Valve

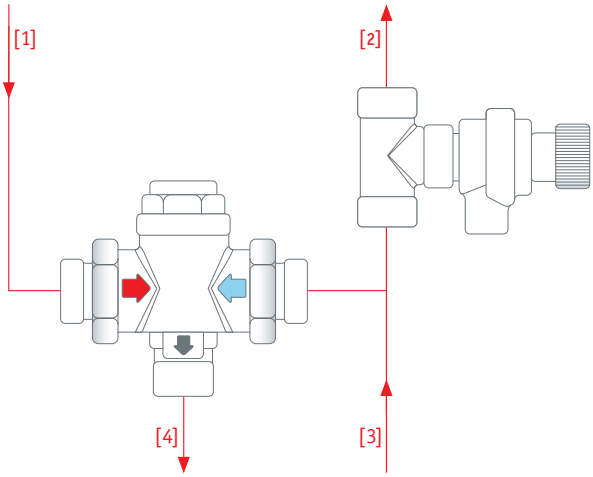
The freeze protection valve can protect collectors from freezing damage at mild low temperatures, and is suitable for open-loop systems installed at locations with short periods of sub-zero temperatures. The 3/4" external thread valve should be screwed into the lower collector's manifold as a plug. The valve opens and drips when the valve's actuator, dipped in the lower manifold, drops to 1.7°C. The valve's opening enables the storage tank's water to enter the collector. The valve closes at 4.4°C, when hotter water reaches the actuator.

Remember not to insulate the valves body!



8.5 Thermostatic Mixing Valve

Thermostatic mixing valve is fitted between the solar water heaters hot water outlet pipe and the home hot water piping system. Its purpose is to ensure that water temperature does not exceed 50 °C in order to avoid burns and piping damage.



[1] Tank's hot water outlet
[2] Tank's cold water inlet
[3] Cold water supply
[4] Controlled hot water to user

8.6 Anti-Scale Filter

The anti-scale filter protects open-loop systems from scale build up. This anti-scale filter is a plastic filter containing polyphosphate (siliphos) crystals. Siliphos reduces the amount of scale deposits by keeping the minerals, which cause scale, in a dissolved and suspended state at higher temperatures. As a result most scale-causing minerals pass through the system instead of forming scale deposits near the heating element or in the collector.

Siliphos is classed as a 'food grade' additive which conforms to EN1208 and WHO standards as a safe additive for drinking water. Therefore it can be installed directly on the cold water supply to the tank, and the customer can safely bath in or even drink the water that has passed through the filter.

Siliphos reduces its volume in proportion to the amount of water passing through the anti-scale filter which will vary according to specific domestic circumstances. The siliphos fill should be changed every 1.5 years.

Index: Glossary of Terms

Abbreviation	Corrective Action
ALUM	Aluminum
COL.	Collector
cm	Centimeter
D.J.	Double-Jacket
DIAG	Diagonal
DIAM.	Diameter
F	Female
GL	Gallon
hr	Hour
L	Liter
M	Male
mm	Millimeter
N	Narrow
P	Page
PRESS	Pressure
QTY.	Quantity
TEMP	Temperature
TLSCPc	Telescopic
Vol.	Volume
W	Wide

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