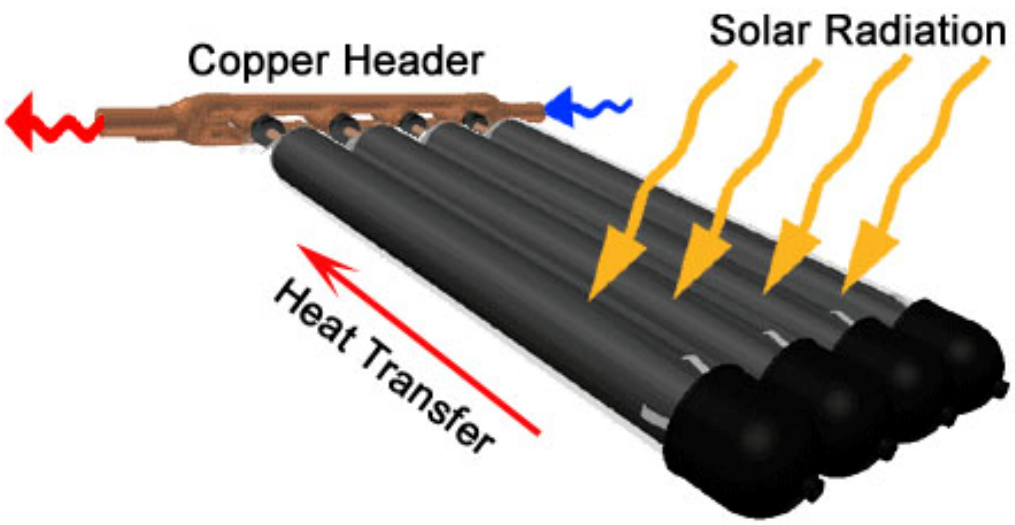
SUNPOWER SPA Series Heat Pipe Solar Collector

I. Introduction

1. Reliable, efficient, evacuated tubes
2. Copper heat pipes for rapid heat transfer
3. Easy plug-in installation
4. Maintenance Free
5. Suitable for mains pressure water (working pressure: 0.6MPa)
6. Corrosion resistant copper header
7. All stainless steel frame and manifold cover (SUS304 food grade Stainless Steel)
8. Stable solar conversion throughout the day
9. The perfect solar collector for domestic solar water heater systems
10. Ideal for commercial solar water heating applications



The operation of the SUNPOWER solar collector is very simple.

1. Solar Absorption: Solar radiation is absorbed by the solar tubes and converted into heat.

2. Solar Heat Transfer: Heat pipes conduct the heat from within the solar tube up to the header pipe.

3. Solar Energy Storage: Water is circulated through the header, via intermittent pump cycling. Each time the water circulates through the header the temperature is raised by 5-10^{o}C / 9-18^{o}F. Throughout the day, the water in the storage tank is gradually heated.

Hodler-Gemeinhardt GbR – Brabeckstrasse 142 – 30539 Hannover
Tel: +49 (0)511 3632003 Fax:+49-(0)511-9525629
Email: info@motomarkt.de

II. Main Features Overview

1. Water pressure

The SUNPOWER solar collector is designed with pressure up to 0.6 MPa. This means it is compatible with all low pressure, and most mains pressure domestic hot water systems. In closed loop systems a pressure release valve is often used as a safety backup.

2. Closed and open loop

Closed loop systems usually incorporate the use of a heat exchanger, either inside or outside the hot water storage tank. In areas where freezing is not of concern, open loop systems are often used. SUNPOWER solar collector is suitable for both open and closed systems, as long as pressure, heat and freezing are controlled.

3. Pump requirements

SUNPOWER solar collector does not have a built-in tank, in fact the manifold of the 20 tube solar collector only contains about 510ml/1pint of water. A circulation pump is required to circulate the water through the manifold and back to the solar storage tank. Generally a 2-sensor controller is used to control the pump. A flow rate of only 2L/min is required for most domestic installations, and therefore a low wattage pump is sufficient. Larger pumps are only necessary when several solar collectors are connected in series, or when the pump is required to overcome head pressure. The pressure drop at low flow rates is very minimal, only 700 Pa @ 3.3L/min for 20 tube manifold, and so is not a major consideration when sizing pumps.

4. Freeze protection

Thick polyurethane foam surrounds the SUNPOWER solar collector's copper header, providing excellent insulation. The piping to end from the collector are however still susceptible to freezing, and therefore traditional freeze protection should be employed (low temp controller setting, or glycol/water closed loop). Solar tubes and heat pipes are able to withstand extremely cold conditions without being damaged.

5. Efficiency

The advantage of solar tubes is that they insulate the inner tube from heat loss. This means that once heat is absorbed, it is transferred to the water in the manifold, and not lost to the outside environment. This is the key difference between solar tubes and flat plate solar collectors: the insulative properties. Combined with the heat transfer efficiency of the heat pipe, the SUNPOWER solar collector can deliver excellent heat output all year round.

6. Aesthetics

When installing a solar collector on your roof, how it looks is certainly important. The SUNPOWER solar collector is designed to be low profile, sitting close to the surface of the roof. The tubes are black and so blend in nicely with most roof colors. The manifold is available in stainless steel, and with either rear (R) or end (E) port models. The rear port manifold allows the plumbing to be hidden behind the solar collector manifold. In addition, by using rear ports, two or more solar collectors may be connected side by side without a gap in between. End ports may be preferred for large-scale applications for ease of connection in series, and reduction of pressure drop through the piping.

7. Corrosion

Corrosion is always a consideration for any system that involves water and high temperature. In warm environments, heavily chlorine water can become a strong corrosive agent. In order to provide maximum corrosion resistance, the SUNPOWER solar collector uses high purity (99.93%) copper piping for the header. Copper provides excellent corrosion resistance and is commonly used in household plumbing. If corrosive liquids are to be used in the system, then a closed loop is highly recommended, thus allowing a non-corrosive liquid to be used in the solar collector loop.

If installed in open flow with a dead water thermal store style tank, corrosion and scale are almost eliminated, as the system accepts almost no fresh water supply.

8. Cost

The high cost of solar tube style collectors, and in fact all solar collectors, have been a major obstacle to their popularity and wide scale use. The SUNPOWER solar collector is a high quality system that provides excellent heat output and reliable operation. As a result of clever product design and low manufacturing cost, SUNPOWER solar collectors are now very affordable, providing fast payback times.

9. Scale Formation

Scale formation is an issue in many regions, as it gradually blocks up plumbing particularly in hot water systems. With the high temperature that the SUNPOWER solar collector produces, scale formation in the manifold may occur. If water supply is very hard, there are three main options:

1. Use an electric or magnetic water softener on plumbing
2. Use a closed loop system
3. Use a dead water thermal store configuration. Option 1 may still be required to protect the

rest of the system.
A closed loop requires a more complicated system design and added cost. If there is no other reason to use a closed loop than to avoid scaling, then it is advisable to use one of the widely available water softening devices.

10. Large scale applications

SUNPOWER solar collectors are ideal for large-scale solar water heating applications, which can be used in hotels, airports, apartment buildings or anywhere where hot water or heating is required. The economics of large-scale applications are generally more favorable than domestic, as instead of having a pump and tank for every one or two solar collectors, a single tank and pump can be used for 50 solar collectors. SUNPOWER solar collectors can accept mains pressure, are corrosion resistant and can be installed in series and/or parallel, thus are suited to a wide range of large-scale and small-scale applications.

III. Technical Information

SUNPOWER Solar Collector General Specifications	
Manifold Casing Material	SUS304 grade stainless steel
Frame Material	SUS304 grade stainless steel
Header Pipe Material	C12200 Copper
Insulation	Polyurethane foam
Rubber Seals and Rings	Stabilized high temperature silicone rubber
Optimal installation angle	30-70^{o} Vertical, 0 Horizontal
Maximum Operating Pressure	0.6—0.8 MPa
Optimal flow rate	0.1L/min/tube - 0.026G/min/tube

Model	Heat Pipe			Effective Absorber Area (m2)	Brutto Absorber Area (m2)
	Diameter	Length	Number		
SPA58/1800-20	58mm	1800mm	20	2.088	3,47
SPA58/1800-24	58mm	1800mm	24	2.5056	4,16
SPA58/1800-30	58mm	1800mm	30	3.132	5,2

1. Length and width do not include the inlet and outlet that protrude from either the rear or end of the manifold.

2. Absorber area calculated as: D x L x N where:

...D = diameter of the absorber tube, in this case 0.047m or 0.058m

...L = exposed length of tube: 1.5m/1.8m

...N = number of tubes (20, 24, 30)

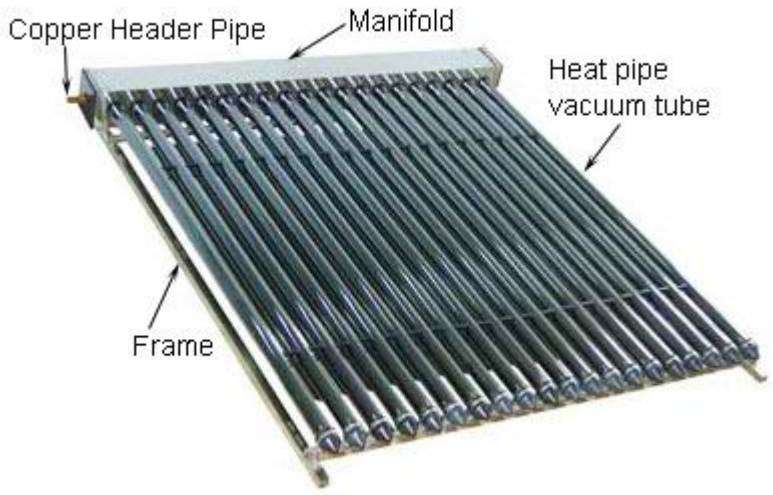
...E.g. 0.047 x 1.5 x 20 = 1.41m^2 effective absorber area (1m^2 = 10.76ft^2)

3. Calculated simply as overall length (including frame) x overall width.

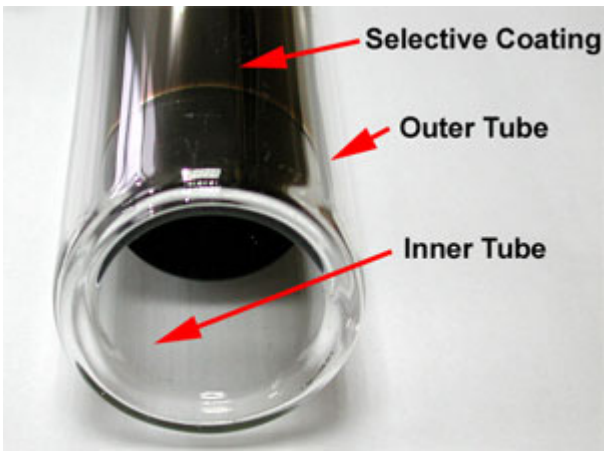
IV. Key Components

The SUNPOWER solar collector design incorporates 3 main components:

1. Vacuum tube and copper heat pipe
2. Manifold
3. Mounting Frame



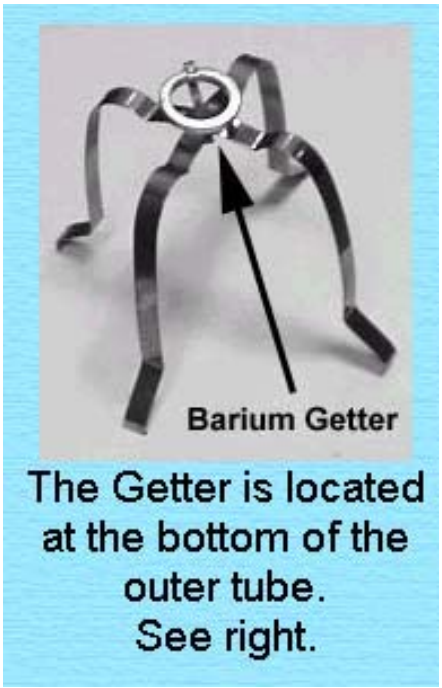
Vacuum Tube & Heat Pipe

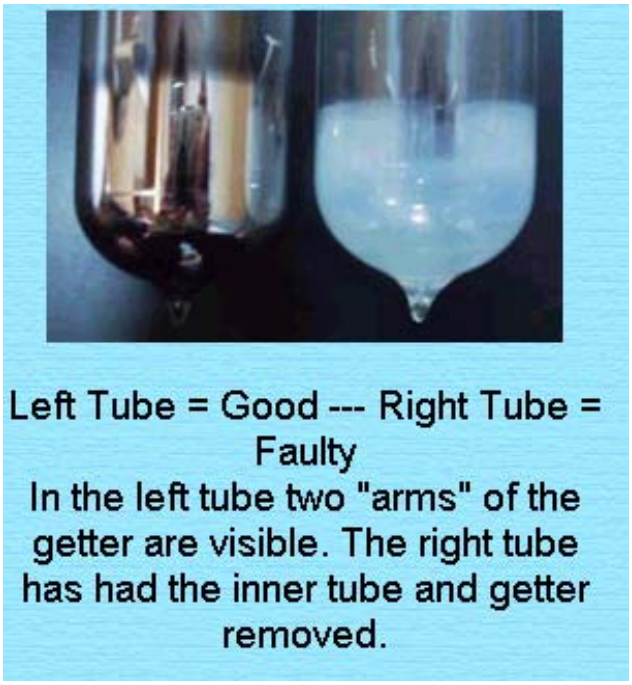


Glass vacuum tubes are the key component of solar water heaters and solar collectors. Each vacuum tube consists of two glass tubes. The outer tube is made of extremely strong transparent borosilicate glass that is able to resist impact from hail up to 25mm in diameter. The inner tube is also made of borosilicate glass, but coated with a special selective coating (Al-N/Al), which features excellent solar heat absorption and minimal heat

reflection properties. The air is withdrawn (evacuated) from the space between the two glass tubes to form a vacuum, which eliminates conductive and convective heat loss.

In order to maintain the vacuum between the two glass layers, a barium getter is used (the same as in television tubes). During manufacture this getter is exposed to high temperature, which causes the bottom of the vacuum tube to be coated with a pure layer of barium. This barium layer actively absorbs any CO, CO2, N2, O2, H2O and H2 out gassed from the tube during storage and operation, thus helping to maintaining the vacuum. The barium layer also provides a clear visual indicator of the vacuum status. The silver colored barium layer will turn white if ever the vacuum is lost. This makes it easy to determine whether or not a tube is operating correctly. See picture below.





Vacuum tube solar water heater and solar collectors still provide excellent results on cloudy days. This is because the tubes are able to absorb the energy from infrared rays which can pass through clouds. Wind and low temperatures also have less of an effect on the function of evacuated tubes when compared to flat plate solar collectors due to the insulating properties of the vacuum.

Glass vacuum tubes are aligned in parallel; the angle of mounting depends upon the latitude of your location. In a North South orientation the tubes can passively track heat from the sun all day. In an East West orientation they can track the sun all year round. The shape of the tubes provides superior absorption when compared to flat plate collectors for a number of reasons:

1. As the tube is round, the sun's rays are always striking the tubes surface at right angles, thus minimizing reflection.

2. If the collector surface is flat, the amount of solar radiation striking the collector surface is only at its maximum at midday when the sun is directly above the collector. In the morning or afternoon the sun's rays strike the collector's surface at an angle, and thus the amount of solar radiation that the collector is exposed to is reduced.
Evacuated tubes, however, are round, and thus the amount of solar radiation striking the collector is relatively constant from mid morning to mid afternoon. This feature maximizes the total amount of solar radiation the collector is exposed to each day. Furthermore, the sun is always striking the tubes at an angle, which is perpendicular to their surface thus reducing reflection.

The inorganic normal heat tube consists of the glass vacuum tube described above. In addition a copper heat pipe is installed within the tube. The copper heat pipe transfers from within the vacuum tube to its tip (condenser), which is plugged into the header pipe contained in the manifold. As water runs through the header pipe, heat is transferred from the copper heat pipe to the water.
The diagram to the left shows the glass vacuum tube, copper heat pipe, and contoured aluminum heat transfer fins. The heat pipe is simply inserted into the glass tube, sandwiched between the two aluminum fins. The fins are molded to maximize contact area with both the heat pipe and the inside surface of the vacuum tube. This fin design greatly improves heat transfer to the copper heat pipe, and ultimately the water in the manifold.

The heat pipe transfers heat to the manifold by a very simple method. The copper heat pipe is hollow and contains a patented inorganic non-toxic heat-transfer liquid. The hollow center of the heat pipe is a vacuum, so that at even at temperatures of around 25-30oC the compound will vaporize.

When heated the vapor rises to the tip (condenser) of the heat pipe where the heat is transferred to the water flowing through the manifold. The loss of heat causes the vapor to condense and flow back down the heat pipe where the process is once again repeated. Heat pipes using inorganic heat transfer compounds exhibit heat transfer performance that is up to 30,000 times that of silver.

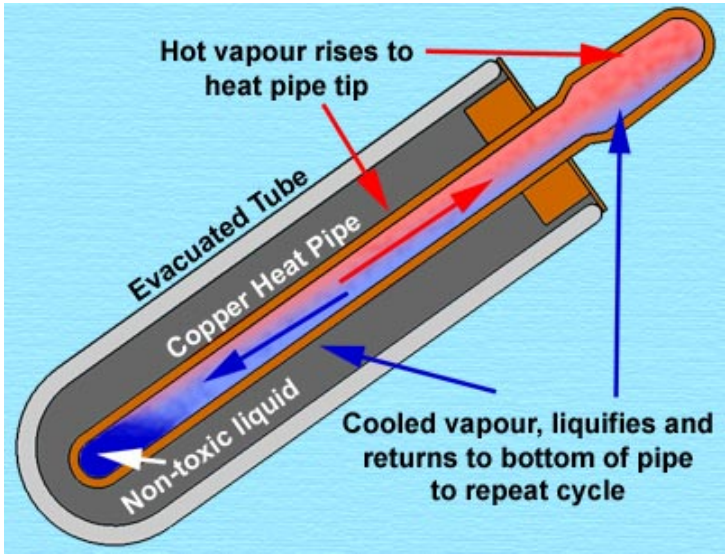
Using inorganic heat pipes, heat is very efficiently transferred from the glass-evacuated tube to the water. Heat pipes are widely used in many applications including air conditioning and computers (CPU cooling), as they provide reliable long-term performance.

We use heat pipes from a reputable manufacturer using a US patented inorganic heat transfer compound. This compound is nontoxic if ingested and does not irritate either eyes or skin. Even so, during normal use, the heat pipe is never in direct contact with the liquid circulating through the header pipe.

Inorganic heat pipes have a vacuum level of 4 x 10-6 Pa, which allows the heat transfer

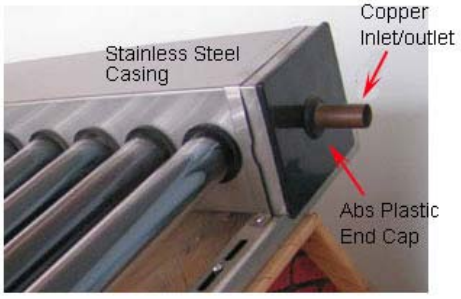
compound to vaporize at low temperatures of 25-30℃.

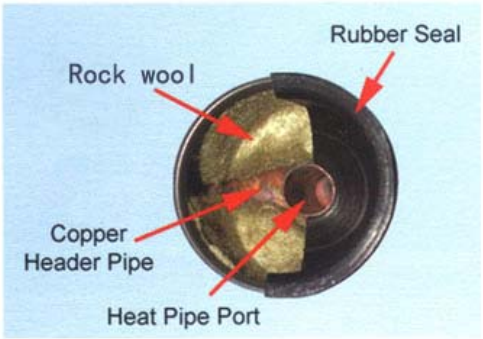
Every heat pipe used by Focus is individually tested for heat transfer performance and welding quality before being accepted for use.

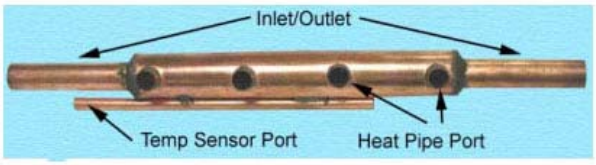


Manifold

The Manifold consists of copper header pipe, Polyurethane foam and Manifold Casing.







Hodler-Gemeinhardt GbR – Brabeckstrasse 142 – 30539 Hannover
Tel: +49 (0)511 3632003 Fax:+49-(0)511-9525629
Email: info@motomarkt.de

The SUNPOWER solarcollector's header is designed to providing excellent heat transfer and corrosion resistance while using a simple” plug in" installation method.

The key features are as follows:

1. Heat pipe ports provide simple plug in installation while still ensuring tight contact with the heat pipes for optimal heat transfer. Thermal heat conduction grease is applied to the heat pipes condenser prior to insertion to further enhance heat transfer. Given the high temperature that the manifold is exposed to, the expansion of the heat pipe condenser and "setting" of the heat conduction paste results in the heat pipe being firmly held in place. This ensures excellent heat transfer for the life of the solar collector. As the heat pipe is extremely reliable and durable, there is no need to ever remove or replace the heat pipe, even if change a solar tube.
2. The twin header pipes are molded to match the shape of the heat pipe ports in order to maximize contact area. In addition, the heat pipe ports are brazed to the twin header pipes providing a direct metallic connection**.**
3. The "contoured" header pipe design produces turbulent water flow enhancing heat transfer.
4. Available in rear port or end port inlet/outlet configuration.
5. 8mm ID copper temperature sensor ports at both the inlet and outlet that are brazed directly to the header pipe for accurate temperature measurements.

The layer of heat preservation adopts polyurethane to expand foam integrally. Its density is high and its strength is good. It can keep superior the property of heat preservation all the time.

The manifold casing serves two main purposes, protecting the header and polyurethane foam from the elements, and aesthetics. Protection from the elements and long-term corrosion resistance is achieved.

Mounting Frame

The mounting frame of SUNPOWER solar collector is made of SUS304 stainless steel. The SUNPOWER solar collector can be installed on most roof surfaces, and a full range of roof angles. A standard frame is provided with all collectors, and additional frame kits are available to suit most common installations. The various frame components can also be used to install on most other non-standard surfaces.

The frames are designed to withstand winds of up to 180km/h / 112mph, however attachment points must also be strong enough to withstand significant pull forces that will occur during strong winds.