TrendSetter®
Solar Products, Inc.

Premium Super Heat Pipe
Solar Thermal Collector

Product Overview

Product Range

TRENDSETTER® specializes in high quality solar thermal products for hot water production. This document focuses on the premium vacuum tube solar thermal collectors

Premium Collector Certification

TRENDSETTER® is currently under SRCC certification testing for its premium vacuum tube collector which it shortly expects to attain by December 2007

SPECIFICATIONS OF THE TRENDSETTER® PREMIUM COLLECTOR

Description

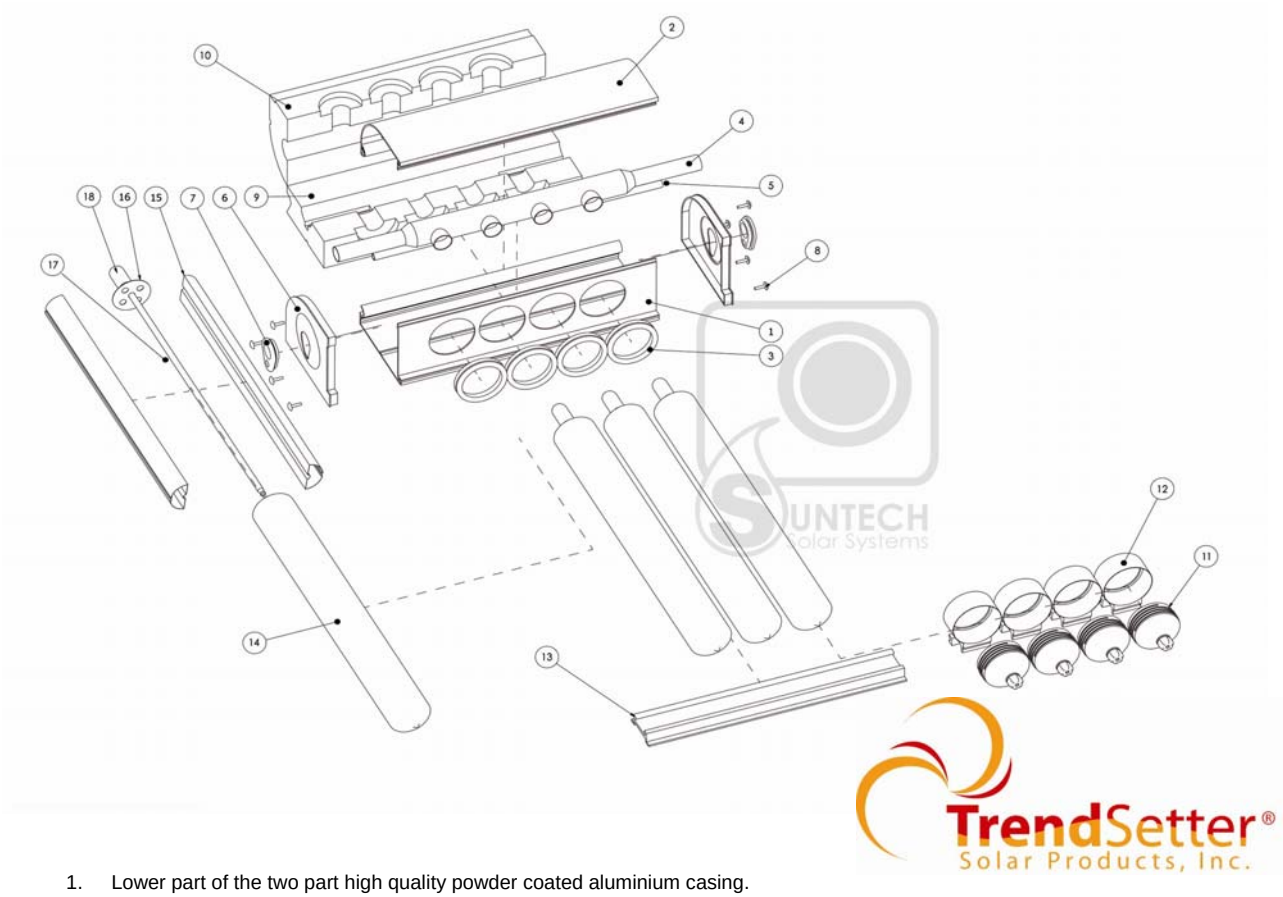
The TRENDSETTER® premium collector is a thermal solar collector that uses twin glass evacuated tubes as the solar absorber. Copper heat pipes are used to transfer the heat from within the evacuated tube to a heat transfer manifold, with metal fins positioned within the evacuated tube to aid heat transfer and hold the heat pipes firmly in place.

The heat transfer manifold consists of a copper header pipe through which heat transfer liquid (water or water-glycol mix) is circulated. The header is designed with dry contact ports into which the heat pipes plug, allowing efficient heat transfer. There is no water inside the evacuated tubes and no direct contact between the heat pipes and the heat transfer liquid, as such the system is suitable for mains pressure.

The manifold and tubes are attached to a stainless steel mounting frame, which can be mounted directly on a roof of suitable pitch. Frame kits are also available which allow mounting on flat roofs, walls or low-pitched roofs. By using commercially available frame kits, pole mounting is also possible.

The TRENDSETTER® solar collector has been designed to be suitable for a wide range of system configurations including open loop, closed loop, drain back and even thermosyphon when coupled with a suitable tank. Collectors may be installed in banks of up to10collectors in series (300 tubes maximum) and unlimited parallel-connected banks. Collectors can be used for both domestic and commercial applications.

Identifying the Parts



1. Lower part of the two part high quality powder coated aluminium casing.
2. Upper part of the two part high quality powder coated aluminium casing
3. Tube Inner silicone ring seals.
4. All copper, British design and engineered heat exchanger.
5. Controller sensor pocket located each end of the heat exchanger.
6. Outer casing UV stable covers
7. Silicone UV stable seals allowing 22mm and 8mm copper pipe
8. Stainless fixings of the outer cover to the inner casing lugs.
9. Lower section of the compressed and formed rock wool insulation
10. Upper section of the compressed and formed rock wool insulation
11. Male section of two part, UV stable tube holder with fast turn screw thread
12. Female section of two part, UV stable tube holder with fast turn screw thread
13. Aluminium powder coated tube holder track.
14. Evacuated all glass tubes, high quality, latest absorber coatings.
15. Aluminium two part heat transfer fins in one length for a central HP location.
16. Stainless steel vent plate combined heat pipe positioning.
17. All copper super heat pipe.
18. Heat pipe condenser.

Basic Collector Data

Collector Size	10 Tubes	18 Tubes	22 Tubes	30 Tubes
Overall length[1]	1980mm / 80”			
Overall height[2]	156mm / 6.4” (manifold & standard frame)			
Overall width[3]	796mm / 31.3”	1496mm / 58.8”	1636mm / 64.4”	2196mm / 86.4”
Absorber area[4]	0.8m^2 / 8.6ft^2	1.6m^2 / 17.2ft^2	1.76m^2 / 18.9ft^2	2.4m^2 / 25.8ft^2
Aperture area[5]	0.94m^2 / 10.1ft^2	1.88m^2 / 20.2ft^2	2.07m^2 / 22.3ft^2	2.82m^2 / 30.3ft^2
Gross area	1.57m^2 / 16.95ft^2	2.96m^2 / 31.8ft^2	3.24m^2 / 34.8ft^2	4.35m^2 / 46.8ft^2
Gross dry weight – standard frame	34.8kg / 76.5lb	63.5kg / 139.7lb	71.3kg / 156.8lb	94.8kg / 208.5lb
Fluid capacity	500ml	900ml	1,100ml	1500ml

1 Length of frame front track;

2 Height of frame front track & manifold

3 Width of manifold (not inc. inlet/outlet ports)

4 Absorber = outside diameter of inner tube x exposed tube length

5 Aperture = inner diameter of outer glass tube x exposed tube length

Glass Material	Borosilicate Glass 3.3
Absorber Material	Graded-index coating A1-N on A1 on glass
Thermal Expansion	3.3x106°C
Absorptance	>92%(AM1.5)
Emittance	<8% (80°C)
Vacuum	P<5x10^{-3}Pa
Stagnation Temp.	>200°C >395°F
Heat Loss	<0.8W / (m²°C)
Maximum Strength	0.8Mpa 120psi
Absorber Area per Tube (for standard performance calcs)	0.08m² 0.86ft²
Heat Transfer Fins	0.3mm / 0.0098” thick sets of Aluminium Fins

Super & Standard Heat Pipes

Length	1800mm 70.88" – 1500mm/59.0"
Material	∅8mm OD x 0.7mm ∅0.314” OD x 0.027” Oxygen Free Copper (TU1) Cu=Ag>99.99% ($0_{2<16ppm}$)
Condenser Dimensions	∅20mm OD x 30mm ∅0.78” OD x 1.18”
Heat Transfer Liquid	Water
Maximum Working Temp.	300°C 577°F
Start-up Temp.	SH pipe<30s (80°C) <190°F – ST pipe<60s (75°C) <180°F
Heat Exchange Output	>100W - >135W
Vacuum	P<5x10^{-3}P
Vertical Installation Angle	20-70°
Horizontal Installation Angle	0° +/-5°

Rubber Components

Material	HTV Silicon Rubber (UV stabilised)
Density	1.15 g/cm^3 +/- 0.05
Durometer Hardness (Shore A)	50-70 (depends on components)
Elongation	320%
Rebound	54%
Maximum Working Temp.	300ºC 577ºF
Tensile Strength	6.4Mpa
Tear Strength	12.5 KNM

Collector Mounting Frames

Frame Options

TRENDSETTER® Solar collectors come with a standard frame for mounting flush to a pitched roof.

Alternative frame kits are available for the following:

Type of Mounting	**Frame Kit Required**
Roof with insufficient pitch	Low Angle Frame Kit
Flat Roof	High Angle Frame Kit (adjustable)
Ground Siting	High Angle Frame Kit
Wall Mounting	NOT Yet Available

Frame Accessories

Mounting Type or Roof Surface	**Accessories Suitable**
Tiled	
Asphalt Shingle	Silicone rounded pads
Concrete	
Corrugated Iron	Silicone U channel pads
Wall	

For more information about frame mounting and installation please contact TRENDSETTER® for the **Frame Mounting Booklet**.

System Sizing

The wide range of sizing options of the TRENDSETTER® Premium Solar Collector allow for heat outputs to be better matched to requirements. The sizing of a system is usually associated with the size of solar storage tank.

Typical daily sizing requirements for apartments is 20 gallons for the first bedroom, 15 gallons for the second bedroom and 10 gallons for the third bedroom.

Typical minimum daily sizing for residential homes is 26 gallons per adult and 13 gallons per child. Add additional usage for a washing machine and dishwasher.

Therefore, it is common to estimate the average family consumes on the average of 80 gallons of hot water per day.

Sizing Example

- < Household using 80 gallons of water per day @ 114ºF
- < Summer cold water temperature of 65ºF
- < Average summer insolation level of 1,902Btu/ft²/day

Step 1. Determine temperature rise

<114 – 65 = 49ºF temp rise

Step 2. Determine energy requirement

<80 gallons x 8.33 lbs/gal = 667.2lb

<667.2lb x 49ºF = 32,692Btu

Step 3. Determine solar collector output / tube

<1902Btu * 70% conversion = 1331Btu per ft² of collector absorber area

< 1331 * 0.86ft² absorber area = 1144Btu/tube/day

Step 4. Determine tube requirements

<32,692 ÷ 1144 = 28.6 tubes

From this sample calculation, it is shown that a 30 tube collector would suit this household perfectly, providing 100% of their hot water needs in the summer and a percentage throughout the year depending on hot water usage patterns and solar radiation levels.

As a general rule, meeting 100% of hot water needs at peak production in the summer will provide an annual solar contribution of:

- Cold region = 50-60%
- Mild region = 60-70%
- Hot region = 70-80%

Energy Output Calculations

In most cases a rough estimation is all that is needed and therefore simple calculations can be used, but it is also of great benefit to understand performance calculations. The followings sections aim to provide a basic overview of calculating collector performance.

Calculating Instantaneous Output

To calculate the output of the solar collector the following factors are required:

- G = Insolation level (W/m²)
- Temperature differential
- Tm = water temperature (being fed to collector)
- Ta = Ambient temperature
- Collector Performance Variables (based on absorber area)
- no (y-intercept; Trendsetter Solar = 0.717)
- a1 (first coefficient of loss; Trendsetter Solar = 1.52 W/m²W)
- . a2 (second coefficient of loss; Suntech Solar = 0.0085 W/m²W²)
- X = (Um-Ta)/G (this is sometimes written as T*m)

The following formula is then used (metric calculations):

Performance = $no - a1 * X - a2 * G * (X)^2$

Example:

⇒ Solar insolation level of 800Watts/m²

⇒ Supply temp to collector from bottom of storage tank of 35°C

⇒ Ambient temperature of 25°C

⇒ Direct angle of incidence (i.e. Midday)

Therefore: G = 800; X = 0.0125

Plugging those figures into the formula:

⇒ $0.717 - 1.52* 0.0125 - 0.0085 * 800 * (0.125)^2$

⇒ $0.717 - 0.019 - 0.0011 = 0.6969 = 69.7\%$ conversion efficiency

Therefore given 800 Watts of solar radiation, the output of the solar collector would be 557 Watts – this is per m² of absorber area. If the calculation was made using collector performance variables based on aperture or gross area, then the output would be based on that sizing.

The absorber area of each TRENDSETTER® Solar evacuated tube is 0.08m² so a 30 tube collector is 2.4m².

The value of 557 Watts should therefore be multiplied by 2.4 to obtain the output value for a 30 tube collector.

⇒ 557 x 2.4 = 1336 Watts or 1.336kW.

Considering Incidence Angle Modifier (Iam)

The above calculation has considered instantaneous heat output, and at midday when IAM is 1. Given the advantages of the round shaped tubes, and resultant favourable IAM curve, heat output can actually exceed these levels either side of midday.

Calculating Daily Or Annual Output

If the calculation of solar collector output over a period of time is required, such as over a day, month, or year a very simple calculation can be made. These calculations are however very general, and are recommended if a fast estimate of heat output is required, such as when sizing a system. For more accurate estimates please use a modelling program such as F-chart or TRYNSYS.

The following calculations are converted from metric values by using the following conversions:

- 1 kWh/m² = 316.74 btu/ft^2 and
- 1 kWh = 3409.4 btu

Daily Calculation

When considering all factors, the following average solar conversion values can be used for TRENDSETTER® Solar collectors:

Cold Blue Sky Winter Day = 60%

Mild Blue Sky Spring/Fall Day = 70%

Hot Blue Sky Summer Day = 90%

On cloudy overcast days reduce above by 30%

Using the average daily summertime solar isolation level, the following calculation can be completed.

For a south facing solar collector situated at 40ºN Latitude on a 30º tilt on June 21st the average daily solar insolation value is 7.68 kWh/m²/day. Multiplying by the conversion efficiency of x 69.7% and a 90% summer day factor yields a collector output of 4.8 kWh/m²/day or (1520 btu/ft^2 /day)

The net daily output for a 30 tube array is 4.8 kWh/m² x 2.4 m^2=11.5 kWh or 25.8ft^2 x 1520 btu/ft^2 = 39,216 Btu

Annual Calculation

When considering all factors, the following average solar conversion values can be used for TRENDSETTER® Solar collectors:

Cold Region = 60%

Mild Region = 65%

Hot Region = 90%

The cumulative twelve month solar production for a south facing 30 tube solar collector situated at 40ºN Latitude on a 30º tilt solar insolation value is calculated to be 2430kWh/m²/year x 0.697 x .65 x 2.4m^2 = 2642kWh. Multiplying 2642kWh by the conversion factor of 3409.4 btu/kWh = 9.0Mbtu

Gas is billed in therms equivalent to100,000 btu. In the above example, assuming an energy factor of 50% the annual savings is 180 therms.

Do Not Oversize The System

Ideally size the system based on summer solar radiation levels and hot water usage. Sizing for winter will result in excess summer heat, which must be safely used or dissipated. There are various system designs that can allow for an oversized system including using the heat for auxiliary heating (spa/hot-tub/pool), dissipating the heat using a radiator and/or tank cooling function, or minimizing summer output by installing the collector at a high angle.

Pipe Insulation

Copper pipe (as commonly used on the solar loop) is a fantastic natural heat dissipater, and therefore if not well insulated the system performance will be greatly reduced, due to passive heat loss. We recommend the use of our Rork Stainless Steel flexible pipe sizes supplied in 10 meter rolls to cut to length as required. A tool allows the flange to be made where required. ALL exposed piping both indoors and outdoors should be heavily insulated, regardless of the climate.

Installation Location

Installation angle (inclination) and direction (azimuth) are both important factors, which should be considered. As a general rule the installation angle should match the latitude of the region, however this may not be the case if the system design needs to minimize summer output.

The azimuth should be as close to due south as possible. Pointing towards the East or West by up to 30° is acceptable and will have minimal impact on the collector output. Pointing the collector at greater angles towards East or West will change the peak period of heat output to morning or afternoon respectively.

Make certain the collector will not be shaded significantly during the day. Early morning before 10AM or later afternoon shading after 3 PM is not a major problem as solar radiation levels are low during these periods anyway.

Safety

Adhere to all relevant safety regulations when completing the installation, in particular health and safety guidelines regarding working on a roof/ladder.

Ensure the collector will not become a hazard in the case of damage. E.g. during a storm if flying debris strikes the collector, tubes may be broken, resulting in broken glass. A consideration of where such glass may fall should be made – if on an area where people re likely to walk, safety measures may need to be employed. E.g. installs a guard below the collector, and/or educates the home-owner.

Warranty

TRENDSETTER® Solar Products provides a comprehensive warranty policy for the solar collector product. Affixed to each collector is a metal plate with a serial number. Please send in the warranty card with the number.

Disclaimer

TRENDSETTER® maintains the right to change dimensions and the characteristics of the product without notice, and is not responsible for misprints.

This booklet is only a guide and as such TRENDSETTER® will not be held responsible for the performance of the system in which its collectors are used or responsible for any damage to person or property that results during the installation or subsequent use of TRENDSETTER® products and related system components.

In all cases a thorough understanding of local regulations, laws and common practices must be made, and adherence to such ensured, before commencing the design or installation of any system incorporating TRENDSETTER® products.

For more information on the TRENDSETTER® Solar collector please visit the website at www.trendsetterindustries.com.