FreeFuelForever
Solar Panels & Pumps

Installation, Operation and Maintenance

of

FreeFuelForever Heat Pipe Solar Collectors

model TZ58/1800-20R

Update 07/17/16

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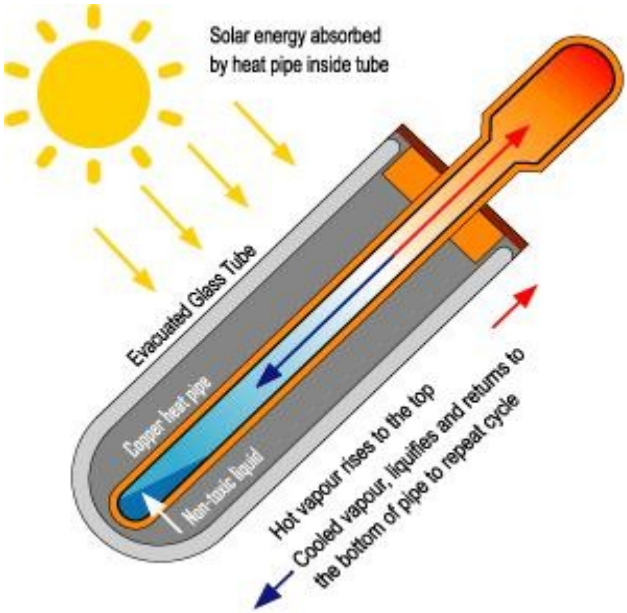
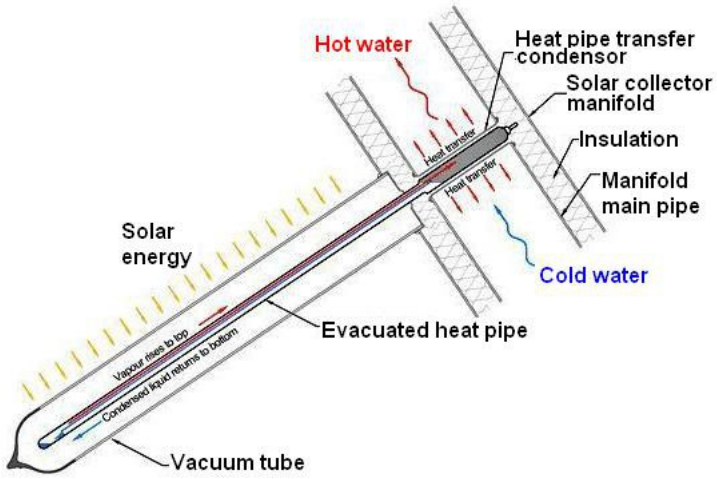
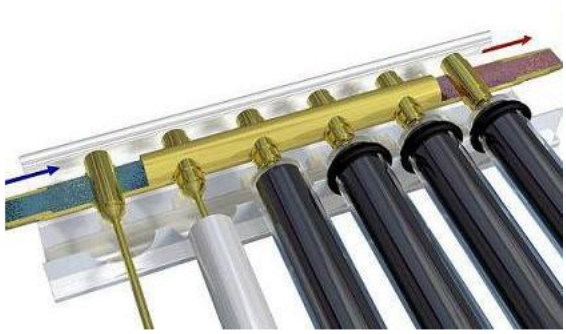
Installation

Theory: Why Heat Pipes Need Angle



Vacuum tubes absorb solar energy and transfer this energy to heat pipes via an aluminium fin. The heat pipe is heated and the working liquid (mostly water) vaporizes and rises to the top of the heat pipe condenser. The condenser bulb is inserted into the mainfold on the solar collector frame. When the heat pipe condenser is cooled by water flowing inside the manifold, the vapour condenses and returns to the bottom of heat pipe. This means that heat transfer to the water is fast, since vapour travels faster than liquid, and efficient, since vapourization takes more energy than liquid heating. Heat is only tranfered one way-there is no way to take heat away from the water. However, for this process to work, the working liquid in the heat pipe has to be able to drip to the bottom, which means that the collector has to be on an angle from 15 to 75 degrees. Heat pipe collectors do not work properly if they are installed horizontally. Use U-Tube collectors for horizontal installations.





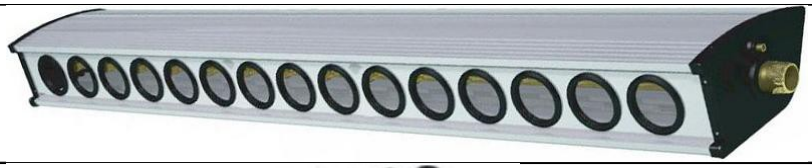
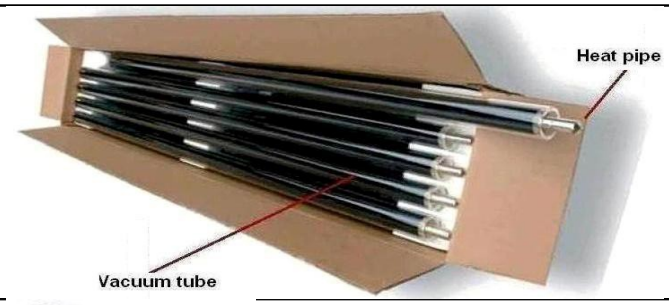
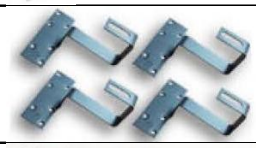
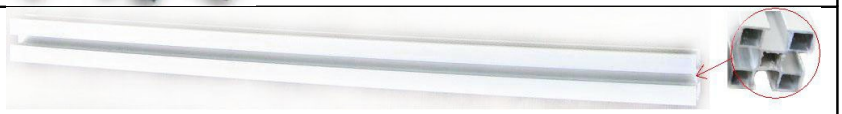
Check solar collector parts

Heat pipe solar collectors are generally packed in three or four cartons. The manifold and tail stock are in one carton, frame in one carton and vacuum tubes in one or two cartons.

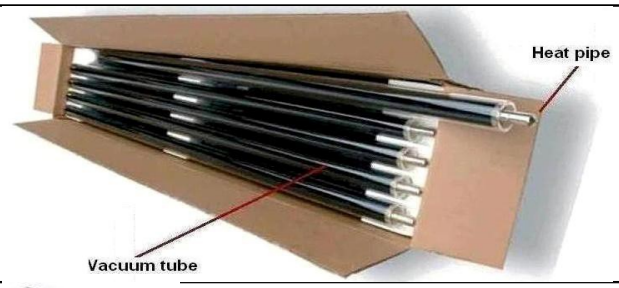
Before installing the solar collector, it is important to open the vacuum tube carton(s), which contain both vacuum tubes and heat pipes. Check to make sure the vacuum tubes are all intact, and the bottom of each tube is still silver. If a tube has a white or clear bottom, it is damaged and should be replaced (See photos below). Each vacuum tube contains an Aluminum heat transfer fin, which holds the heat pipe in place in the center of the vacuum tube. FreeFuelForever heat pipes are centrally located and pre-inserted into the vacuum tubes to reduce your installation time and costs.

Do not remove or expose the tubes to sunlight until you are ready to install them, otherwise the inner tube and heat transfer fin will become very hot quickly and you risk burns. The outer glass surface does not become hot under normal operating conditions. If you wish to install the vacuum tubes into the manifold before commissioning the system, you can place a cover over the whole collector. Do not touch the heat pipe or you risk a nasty burn. We warned you, and remember, we are based in Canada, not the USA, so you can not sue us as easily for these things.

Parts List: Solar collector for Sloping Roof

Manifold (1piece)	
Tail stock (1 piece)	
Silicon grease-purchase from FreeFuelForever as needed.	
Front leg (3 piece)	
Horizontal bar (3 piece)	
Vacuum tube (15 piece/carton)	
Anti-dust circle (Same as tube quantity)	
Nuts	
Sloping roof mounting kits (4 piece/collector)	
Sloping roof solar collector horizontal supporting bar (2 piece/collector, the length will be determined by how many collectors are installed in series)	

Parts List: Solar collector with stand for flat roofs

Manifold (1 piece)	
Tail stock (1 piece)	
Silicon grease-purchase from FreeFuelForever as required.	
Front leg (3 pieces)	
Horizontal bar (3 piece)	
Vacuum tube (15 piece/carton)	
Anti-dust circle (Same as tube quantity)	
Nut	
Side-rear leg (2 piece)	
Middle-rear leg (1 piece)	
Cross bar (4 pieces)	
Longer side bar (3 pieces)	
Shorter side bar (3 piece for 20 and 30 tubes)	
Triangle plate (3 piece for 20 and 30 tubes)	
Feet (6 piece for 20 and 30 tubes)	

Parts List: PV Direct Circulation Pump System:

To make a simple split solar water heater system using a circulation pump driven by a small photovoltaic panel, the following components are needed:

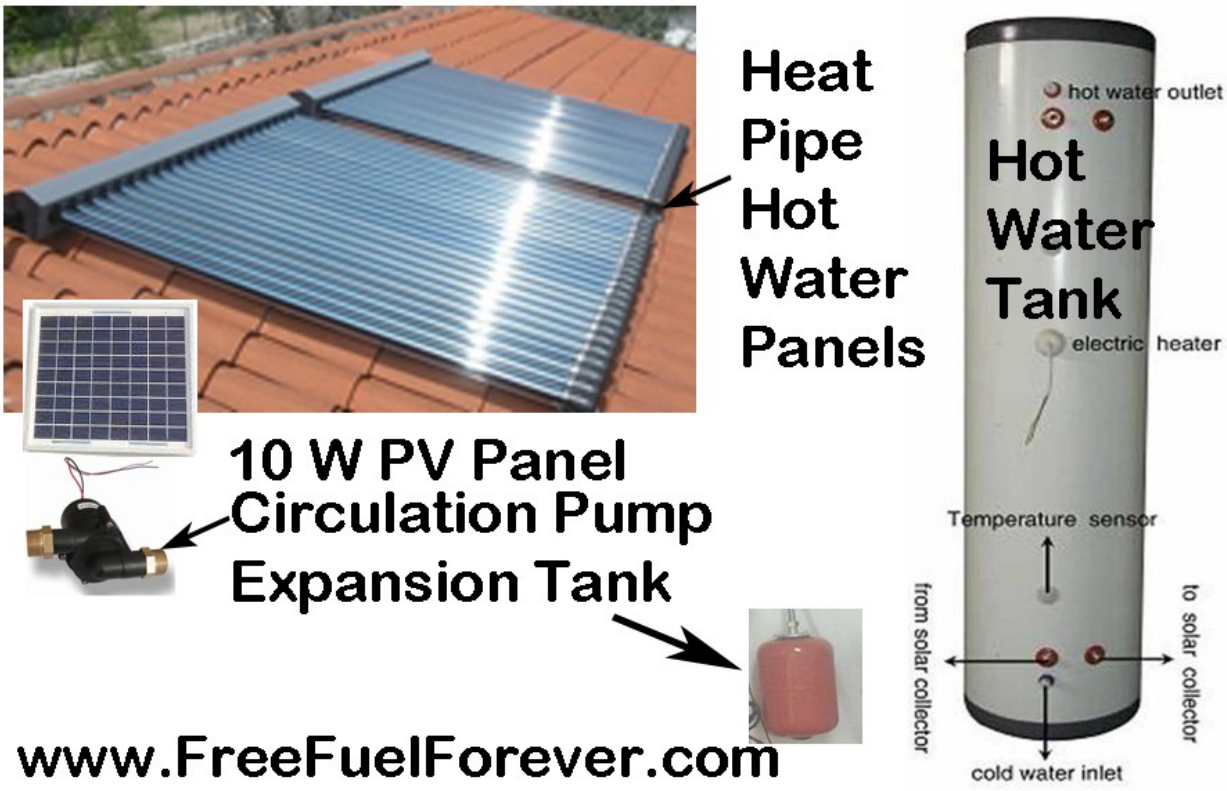
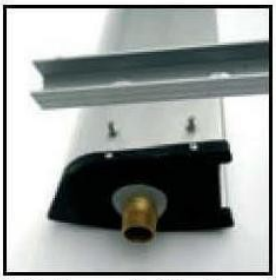


Illustration 1: Components of a simple split solar water heater system, PV direct pump driven

There are many ways to set up a solar water heater system depending on what systems are already in place and the kind of heat required: service hot water, space heat, swimming pool, industrial, etc. The illustration above is one of the more simple and reliable system layouts.

Collector Assembly - Sloping Roof - Pictures


1. Put the manifold back up, install the front legs on the back of manifold


2. Tighten nuts between the front legs and manifold


3. Install the horizontal bars


4. Tighten the nuts between front legs and horizontal bars

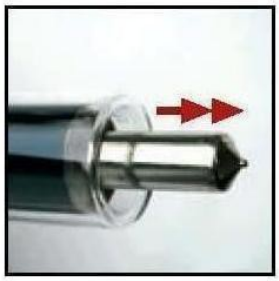

5. Install other horizontal bars ordinally


6. Turn the tail stock back up, install the tail stock on the front legs

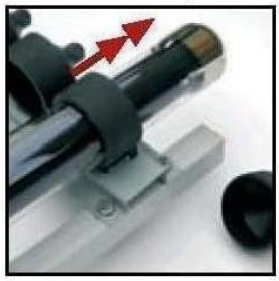

7. Tighten the front legs and tail stock

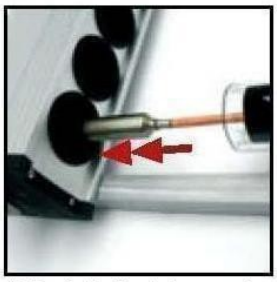

8. Install the anti-dust circles (It's better to smear some soap liquid, so it can lubricate when install vacuum tubes)

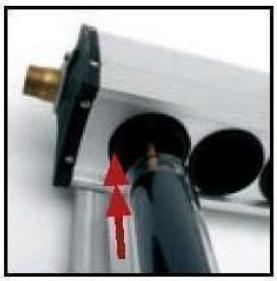

9. Take off the cap of tail stock


10. Pull the heat pipe out a little


11. Smear silicon grease on the surface of het pipe condensor. (Used to increase energy transfer efficiency)


12. Push the vacuum tube into the tail stock


13. Push the heat pipe condensor to the manifold hole, make sure the condensor touch the heat pipe manifold port tightly


14. Push the vacuum tube to the manifold hole, make sure vacuum tube fix with the anti-dust circles tightly


15. Circumgyrate and install the cap of tail stock tightly


16. Check everything and finish the solar collector installation

Collector Assembly-Sloping Roof-Written Steps

1.Fix the bracket on the pitched roof.

2. Fix the pole extrusion on the bracket.

3. Put the collector on the pole and screw into place.

If the heat pipe collector is installed on an inclined, or sloping roof, then rear frames do not need to be installed. After front legs are connected, use corresponding fasteners to fix the collector onto the inclined roof.

For solar projects with more than one collector, connect the collectors with a flexible coupling, as shown. Thread size is either 1 inch, or 3/4 inch female.

Sloping Roof Attachment Steps - Pictures


Step 1


Step 2


Step 3


Step 4


Step 5


Step 6

Step 7


Step 8


Step 9


Step 10


Step 11


Step 12

Collector Assembly - Flat Roof-Pictures


1. Put the manifold back up, install the front legs on the back of manifold


2. Tighten nuts between the front legs and manifold


3. Install the horizontal bars


4. Tighten the nuts between front legs and horizontal bars

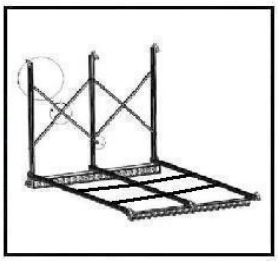

5. Install other horizontal bars ordinally

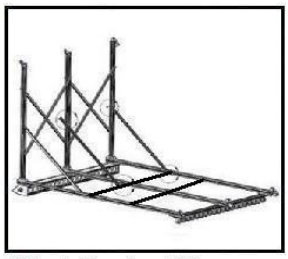

6. Turn the tail stock back up, install the tail stock on the front legs


7. Tighten the front legs and tail stock


8. Install rear legs

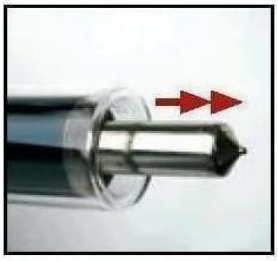

9. Install feet on the front legs and rear legs


10. Install cross bars between the rear legs to creat an "X"


11. Install horizontal bars between the front legs and rear legs

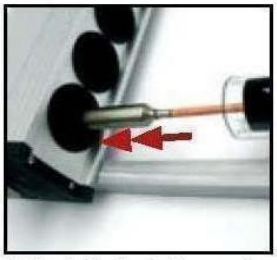

12. Turn solar collector back and install anti-dust circles

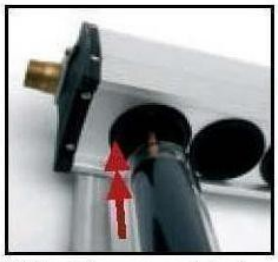

13. Take off the cap of tail stock


14. Pull the heat pipe out a little


15. Smear silicon grease on the surface of het pipe condensor. (Used to increase energy transfer efficiency)


16. Push the vacuum tube into the tail stock


17. Push the heat pipe condensor to the manifold hole, make sure the condensor touch the heat pipe manifold port tightly


18. Push the vacuum tube to the manifold hole, make sure vacuum tube fix with the anti-dust circles tightly

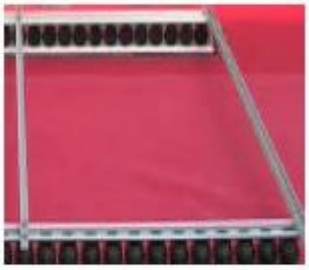

19. Circumgyrate and install the cap of tail stock tightly


20. Check everything and finish the solar collector installation

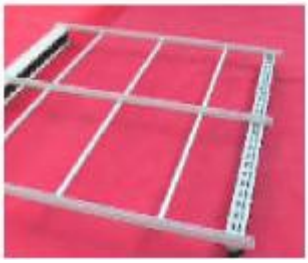
Collector Assembly-Flat Roof-Written Steps

Open the packing case and check accessories related to frames, including front legs, rear legs, assistant bars, cross bars, front horizontal bars, connecting pieces, tail stocks, cousins and screw bags.

Connect the tail stock track with the frames using bolts of the same size. Do not put the tail stock on upside down.



Connect the manifold header with front legs. Do not put the manifold on upside down. Take out the front horizontal bars and use bolts to connect front legs (three total). Take the connecting pieces and rear legs out. Adjust the position and angle. Connect the rear legs and front legs by the connecting pieces one by one.



Connect the front legs with rear legs with the assistant bars. Take cross bars and connect them with screws. Then use the cross bars to connect the rear legs. Take the cousins out and connect them with the front and rear legs in turn. Screw down the adjustable back boxes of the tail stocks. Put the anti-dust circles into the manifold holes so that after the vacuum tubes are inserted, they have a good sealing effect. Insert the heat pipes into the vacuum tube if they are not pre-inserted. Insert the heat pipe condenser head into the heat exchanger of casing head inside the manifold.

Do not rotate the vacuum tubes to avoid scoring and damaging the heat pipe. Remember that the heat pipe head can be hot enough to burn your hand. Screw on the bottom tail stock again and tighten all screws.

The collector should be assembled at angles between 15° (minimum) and 75° (maximum). Steps must be taken to ensure that water and other contaminants such as dust are prevented from getting into the collector connections and air vents.

Traditional System Diagram:

Traditional systems use a temperature sensor with electronic controller to turn on the circulation pump. Dirty water and power interruptions make the sensors and controller the most trouble prone parts of the system.

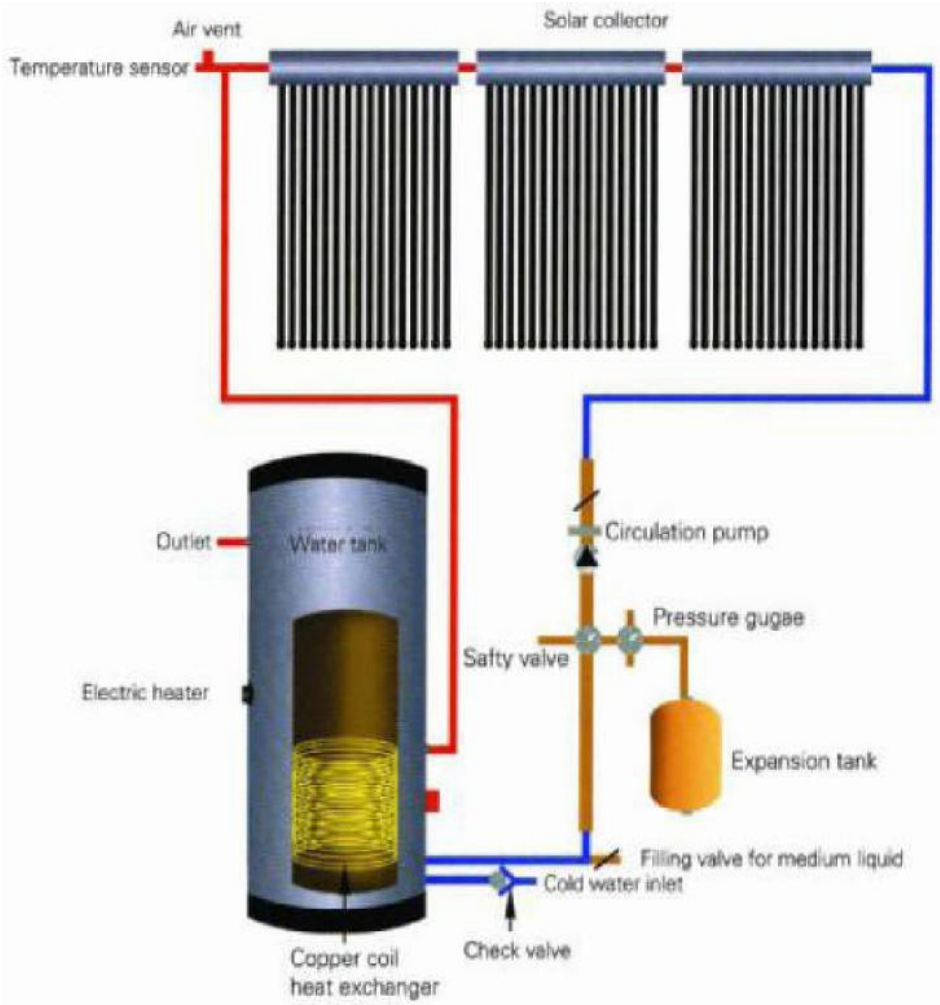


Illustration 2: Traditional split system layout with temperature sensor and electronic circulation pump controller.

PV Direct Pump System Diagram:

To eliminate the electronic controller for the pump, a simpler system uses a circulation pump designed to run with a small 10W or 15 W photovoltaic panel. When the sun is shining, the water is hot enough to circulate and the pump runs. The largest source of failures in solar water systems-the controller-is thus eliminated.

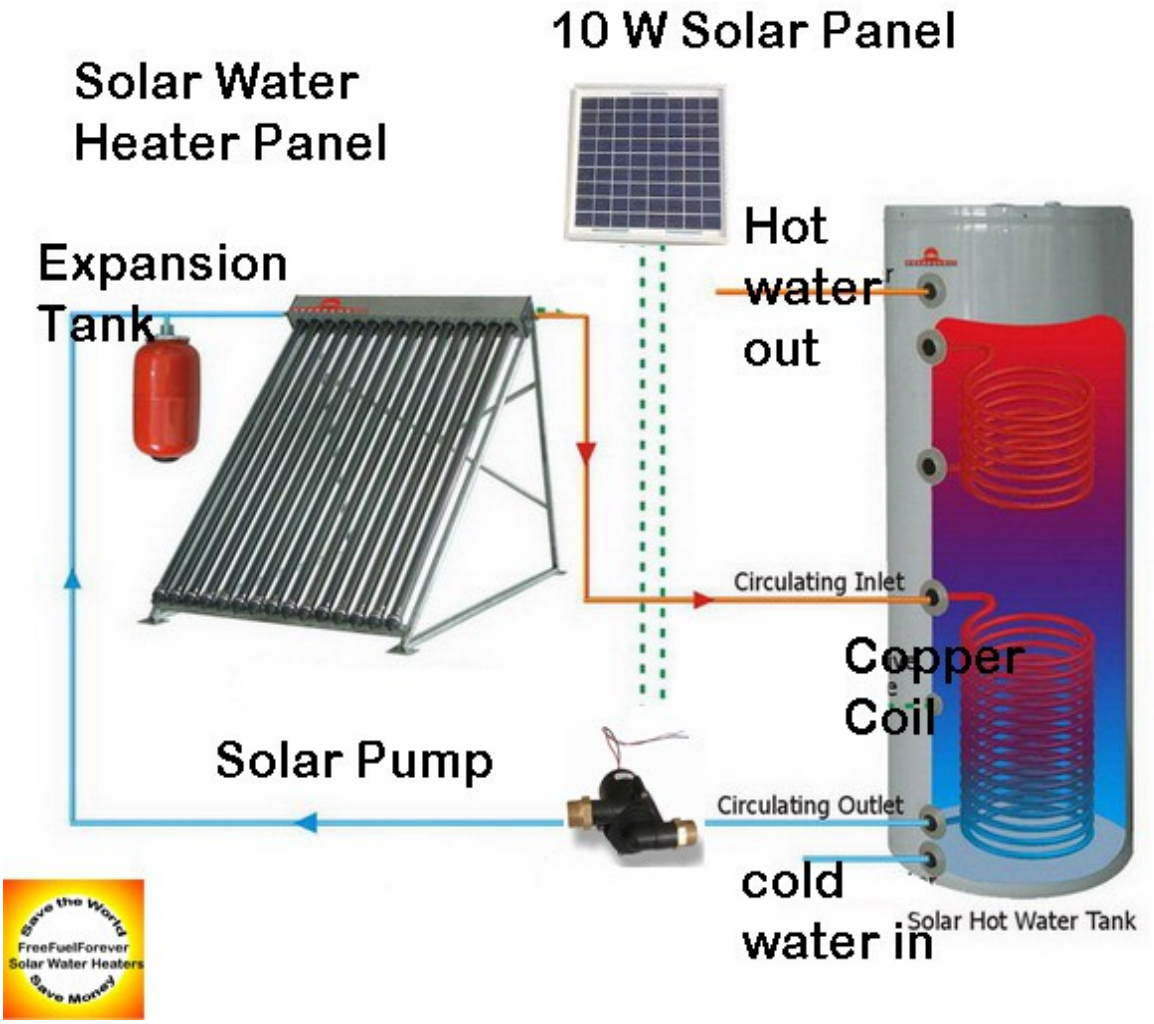


Illustration 3: Photovoltaic direct circulation pump driving a simple split solar water system

Pipes

For connection of collectors, larger pipe sizes should be used, with consideration made to flow rates, pressure drop and pump sizing. A 1" pipe connector is usually suitable. See the split system installation manual and use the pressure drop program from the www.freefuelforever.com website to check pipe size is large enough for the circulation pump and distance. Insulate pipes to stop heat loss protect from freezing. Keep pipe runs short and inside warm parts of the building.

Lightning protection

It is not necessary to connect collector arrays to the lightning protection of the building unless country specific regulations require it. For installations on metal substructures authorized lightning protection specialists must be consulted. It is possible to ground the collectors to a ground rod. The grounding line must be laid outside the house. The ground rod must also be connected to the main potential equalization conductor by a line with the same cross-section.

Wind & snow load

When installing the collector, consider wind and snow loading. In regions of high wind and heavy snow, laws may require an authorized engineer or the local building department to inspect roof attachments. It is the responsibility of the installer to ensure that the frame mounting is to suitable strong points.

Operation

1. The solar collector panel should face the equator, which means south in the northern hemisphere. 10° to 15° angle towards the southwest will catch more of the evening sun if morning mist and fog are problems. Be sure there is no covering on both sides of the panel and its top.
2. Make sure the solar collector is fixed securily to building structure for safety; remember high winds can occur occasionally.
3. For the sake of security, please do not use the hot water until electric outlets close by are earthed.

Circulation loop

During normal operation, the temperature inside the circulation loop rises to 100 C. Under stagnation circumstances, the temperature will be much higher. Hence, all the seals in this loop shall be able to withstand high temperature and high pressure. The following sealing methods are recommended:

Copper pipe joints: requires a resilient seal. Connect a Model A union joint directly with the copper pipe after using a reamer to flare the end. The copper pipe should be malleable enough to compress for the seal. Non-copper pipes: seal with silicon tape and pipe seal compound.

Heat Exchanger Recommendation

In areas where local water is known to be hard or aggressive, a heat exchanger must be used and the use of water softener is recommended, otherwise regular cleaning of the system will be required. A heat exchanger will avoid the problems of corrosion and deposits building up inside the solar collectors. Any kind of liquid may be heated by the heat exchanger. In areas where chloride ion concentration is greater than 40 ppm a heat exchanger must be used in hot water storage tank. The solar system should be filled with distilled or de-chlorinated water, or another clean fluid such as glycol.

Filling the Circulation Loop

See the filling and flushing procedure figure in maintenance section for how to connect the pump and glycol filling bucket. The flow has to be strong enough to carry all the air bubbles away and leave as much heat transfer liquid as possible inside the circulation loop. After circulating some water through the loop, replace the water bucket with a barrel of anti-freeze. When anti-freeze comes out from the drain hose, place the hose into the bucket and adjust the ball valve to make the flow smaller, ensuring that no air bubbles appear in the barrel. Keep the flow running for several minutes.

Check the circulation loop for leaks. Close all valves slowly when there are no bubbles coming out from the outlet hose; adjust the system pressure to about 2 bar. Check if the system pressure has become lower after about 3 hours. If the pressure is lower than 2 bar it shows that there is a leak in the circulation loop. Uncover the collector and start using the system.

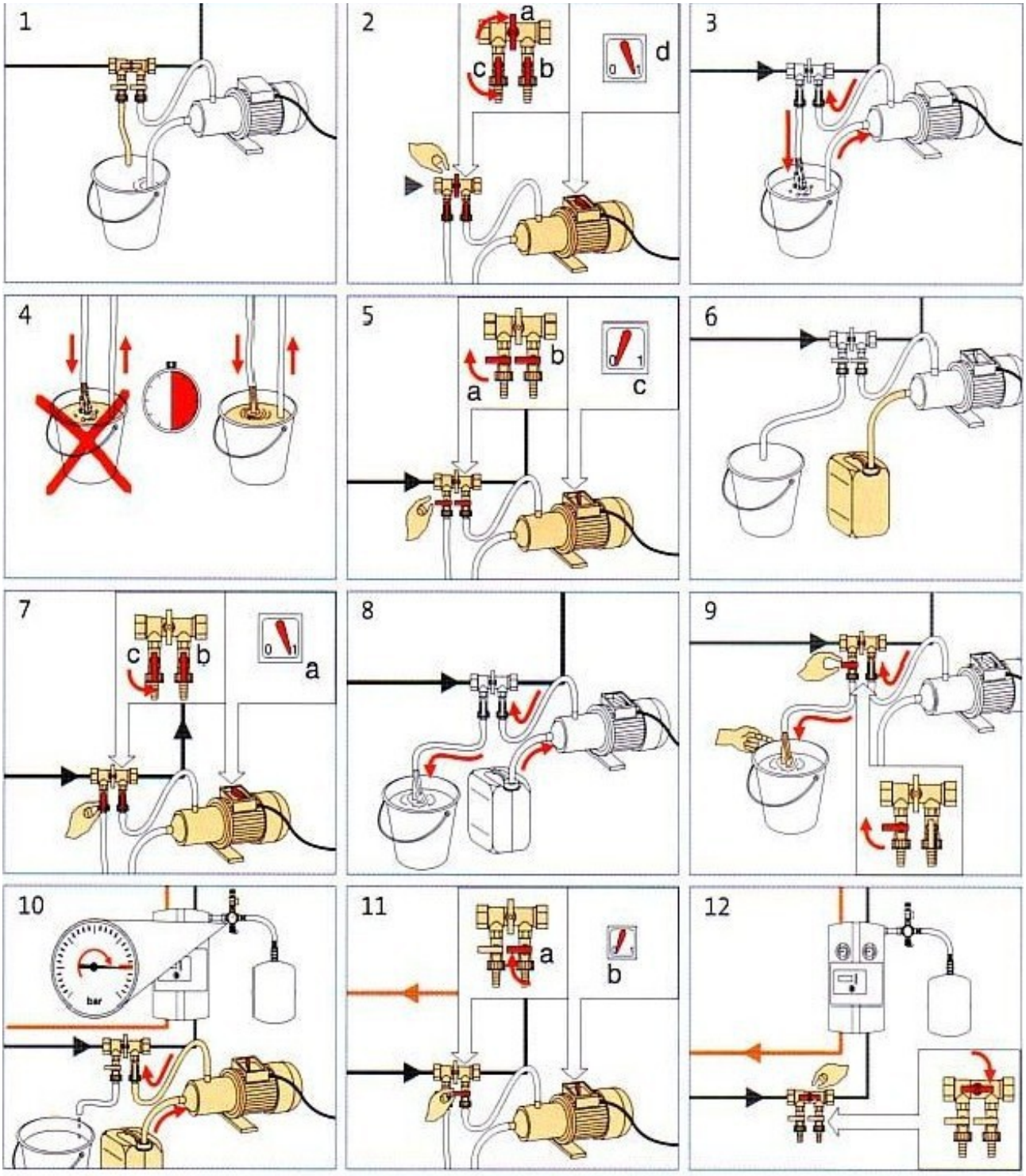
Maintenance

Troubleshooting

Problem	Cause	Remedy
Heat pipe solar collector low working performance-not as much hot water as expected.	a) Clouds and rainy weather in your geographic area. 24 hours of darkness in polar regions.	a) Add more solar collector panels or other backup energy sources, such as gas heating or wood stove.
	b) Solar collector is covered by shade and can not receive enough sunlight	b) Relocated to unshaded area or cut down tree to use in (a) above.
	c) Vacuum tube broken, not silver tip on bottom.	c) Replace vacuum tube
	d) Heat pipe installation incorrect	d) Pull out the heat pipe and daub some silicon grease on the heat pipe's condenser, then reinsert it into the manifold

	e) Solar collector installed on wrong angle	e) Adjust the solar collector and make sure the installation angle is from 15 to 75 degree
	f) Poor pipe seals and insulation, heat loss	f) Check seals for leaks and insulate pipes from tank to collectors, with more insulation for exterior pipe runs. Minimize pipe length and exterior runs.
	g) Faulty heat pipe	g) Replace with new heat pipe and **please tell us, this should not happen.**

Filling and Cleaning Fluid-Pictures



Filling and Cleaning Fluid-Written Steps

Start by flushing the system tank. Open the cold water input valve, close the hot water outlet valve and fill the storage tank. Check if any leaks occur in the cold water pipe and the drain pipe. If no leaks occur, close the cold

water inlet valve and open the drain valve. Close the drain valve with a plug after the tank is empty. Check the hot water pipe for leaks. Supply cold water again and open the water outlet ball valve to check for leaks. Repeat the flushing until the water drained out is clean. Next, flush and fill the circulation loop as the pictures show.

Connect the pump, hose bucket to the valves as shown in the pictures. Open up the fluid return line from the collectors and put it in the bucket. Pump water through the loop until water coming out is clean; this should take about 30 seconds. Throw away the old liquid in the bucket, then pump more clean water through the loop. If there are problems of dirt or bacteria, flush out the loop until the water is clean, then circulate a bucket of soap or diluted bleach through the system, as appropriate to the problem. Then flush with several buckets of clean water. Finally, refill the circulation loop.

Remove air from the circulation loop by pumping water through before switching the pump inlet hose to the supply of glycol. Before shutting down and disconnecting the pump, close the inlet valve so no air has a chance to enter the loop. Then turn off and disconnect the pump. A pump with 30mm pump trap is recommended here.

Heat transfer fluid

The heat transfer fluid (usually water or glycol) in closed loop systems must be checked every two years to check the fluid is not freezing, corroding or plugging up the system.

General Appearance:
Clear fluid is good. Turbid fluid, stained by foreign matter like copper scale, dirt, rust or sealing materials is bad. A dark brown color, pungent odor and degradation products that are not soluble in the fluid indicates thermal overload; the system is stagnating and badly overheating. Bad fluid must be replaced.

Concentration:
The water used to dilute anti-freeze must be distilled water. Mix water and anti freeze in the ratio of 43/57. Excessively **high** glycol concentration, as measured by density or refractive index, is sometimes due to small leaks in "hot areas", e. g. where the collector is connected to the system. Water may evaporate there due to its much lower boiling point compared to propylene glycol (fractional distillation). Most cases of **low** glycol concentration are due to flush dilution. The heat transfer fluid was diluted by water remaining from cleaning or pressure testing. Dilute with distilled water as required.

PH value:

PH value can be used as a general tool to evaluate the state of the corrosion protection of the fluid. The pH value of new, diluted fluid (43/57) is about 10. Factors that shift pH to lower values are thermal load, oxygen, dissolved metal and dirt. If a pH value lower than 7 is measured, corrosion protection will be insufficient, and the fluid has to be replaced.

Disposal of heat transfer fluid

Propylene glycol / water mixtures are readily biodegradable when accidentally released into the environment. The mixtures can be direct released into the sewer system. However, if the fluid is severely overheated, it should be incinerated.