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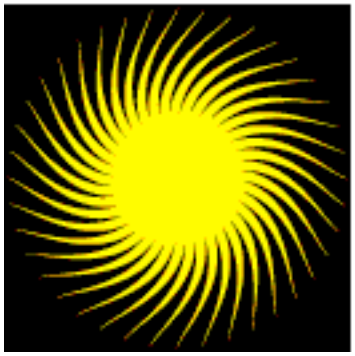

Pressurized Solar Water Heater

featuring SolarH$_2$ot SolVelox Glycol module

User's Manual

The pressurized solar water heater has the following characteristics:

- Brazed plate heat exchanger/pump module manufactured by Solar H$_2$ot. Efficient heat exchanger is separate from water storage tank, so no special tank is needed. Any standard water heater of similar capacity can be used for replacement.
- Sealed solar fluid loop containing a mixture of propylene glycol antifreeze and water.
- Uses industry-standard Armstrong Astro circulators (pumps). Other brands can be substituted for replacement without system redesign.
- Steca control has digital display and advanced features

1. Components

Words that appear in the glossary (at the end of the manual) are in italics the first time they appear in the text.

The *solar loop* of the system consists of a two drain/fill valves with a *check valve* between them, pressure gauge, *pressure relief valve*, *expansion tank*, Astro 30B or Wilo Star bronze circulator to move the fluid through the collectors, and the heat exchanger. The solar fluid is a water/propylene glycol mixture.

The potable loop includes the storage tank, another Astro/Wilo bronze pump, filter screen, and the other side of the brazed plate heat exchanger. When the pump is running it draws water from the bottom of the tank, through the heat exchanger and to a dip tube that distributes it to the middle of the tank, below the level of the electric backup element. As this water is warmed, it rises to the top of the tank, keeping the element thermostat turned off unless it is needed.

The pumps are controlled by a differential temperature control, a Steca TR0301, mounted in the pump module. The control is connected to two sensors, one each at the top of the collector array and at the bottom of the potable water storage tank to monitor temperatures.

2. Description of Operation

When sunlight hits the collectors and their temperature rises to fifteen degrees higher than that of the coolest potable water at the bottom of the storage tank, the differential temperature control switches on 120VAC power to the pump. The solar fluid circulates through the collectors and the heat exchanger in the direction opposite that of the potable water, thereby warming the water in the tank.

Pumping continues until the collectors and the stored water come within four degrees of each other, then the pump turns off. On a day with intense mottling of clouds and sun it is possible for the pump to stop and start several times. This happens especially when the storage water has already been heated to near collector temperatures.

The control includes a high temperature limit. When the lower storage tank temperature reaches the limit -- usually set inside the control at 120 to 140° -- the control shuts off the pumps even if the collectors are still hot. This would typically occur near the end of a sunny day when little domestic hot water had been used.

If the storage tank has reached an excessively high temperature the control may turn on the pump even after the sun is down in an attempt to shed excess heat. In the Steca control this function is set by turning on the "Holiday" mode and we recommend it be enabled at all times.

[The following applies only if the solar and backup heating are combined in one tank.] At times when solar heating has not brought the top of the tank to full temperature, the backup heating thermostat will turn on the electric element or gas burner. This thermostat is behind the access panel on the water heater and is independent of the solar control.

3. Installation

This section is intended to inform the system owner of some of the considerations and logic that went into the installation of solar equipment. It may be helpful if a re-roofing, renovation, or other change demands part of the system be moved. This is not intended as a complete training course in installing the equipment from scratch.

Collectors and Pipes

Your collectors may have been mounted using any of several methods, depending on whether the feet are attached directly to the collector frames or a separate aluminum frame was fabricated to hold the collectors, they are parallel with the roof surface or held up with legs, etc. In all cases each foot has a stainless steel lag bolt that penetrates the roof into solid wood, and each penetration is sealed. The ideal mount faces the collector array south at approximately a 45° angle from horizontal.

If the collectors must be moved for roof repairs consult a solar installation professional beforehand to drain and shut down the system.

4. Maintenance

Five year maintenance items:

1. The propylene glycol antifreeze mixture in the solar fluid should be tested or flushed and recharged.

2. The potable water filter screen at the inlet to the heat exchanger should be checked and cleaned.

3. Your water heater includes an anode rod that protects it from corrosion from the potable water. It also should be checked at least every five years. If the electric element is wired up, **turn off the electric element's 240V (double) circuit breaker or pull the disconnect before draining any water or unscrewing the anode**. To check the rod, turn off the cold water inlet and drain off the hot water pressure down to the level of the top of the tank, then unscrew the sacrificial **anode rod** -- it is the large hex-head in the top of the storage tank (water heater) -- and pull it up to examine the rod. If it is deeply pitted or more than six inches of core wire is exposed at either end of the rod, replace it. After the anode is back in place and the cold-water valve is back on, open several hot water taps long enough to blow air out of the tank and lines before restoring electric power to the element.

Since the **pump is lubricated by the fluid** it pumps, it requires no maintenance, but if it ever sits a month or so without running the fluid can leave deposits that will prevent the pump from being able to start without being taken apart and freed up.

If the system must be left not operating for more than a few days, see "Shut Down", below.

Outdoor pipe cladding, insulation, and caulk should be checked annually. Insulation can be damaged by animals, branches, and ultraviolet rays. In all new installations, we protect the insulation and sensor wire with aluminum cladding. As long as that is in place no maintenance is expected.

If the insulation is not protected by a jacket it should be repainted with an exterior glossy paint. All joints in insulation should be sealed. Pay special attention to where insulation meets the collector or roof flashing. Also check the wire any place it is exposed. The wire should be protected from sunlight. Especially vulnerable if exposed are the two connections to the temperature sensor, located at the exit ("return") pipe at the top of the collectors. Seal the crimp terminals or wire nut connectors with silicone sealant to keep water out. Water will corrode the connections and cause control problems

Indoor pipe insulation, where exposed, should be checked every few years. Patch any areas where shrinkage or damage has caused gaps to form, using insulation rated for high temperatures (rubber foam, isocyanurate foam, or fiberglass; not plastic foam.)

Animals – cats in particular – are attracted to the warmth of the system. The top of a tank makes a great place to sleep. But they also practice scratching on the insulation, and fur is not the best coat for the control and pump. You may have to wrap screen wire around the area to keep them from getting at it. Solar heating systems use propylene glycol antifreeze, which is not harmful to drink -- at least when it is new.

5. Shut-Down

If you plan to be away from home or for some other reason no hot water will be used for days at a time, **leave the power to the solar control ON**. You may, however, want to turn off the power to the backup heating element and turn off the well pump or close the whole house water supply valve, or at

least the hot water shut off. Shutting down the water supply is good insurance against a water leak anywhere in the house, having nothing specifically to do with solar heating.

If no hot water is being used it is possible for the solar loop to overheat. For safety the system includes two pressure relief valves, which open if pressure builds too high from overheating. The one on the top of the water heater can discharge a good deal of water, while the one on the solar loop can discharge a small amount of antifreeze into the drain pan. There are several ways to avoid this inconvenience:

1) Arrange for someone to use hot water while you are away.

2) On the Steca control left side, move the slide switch from "Auto" (middle position) to "On" (upper). This will turn the pump on so at night it can cool the glycol. Be sure to switch it back to "Auto" when you return. The Steca TR0301 control also includes a "holiday" function that will automatically perform a similar function. Check that it is engaged (look for a check mark beside the beach umbrella in the display; see Steca manual.)

3) Secure a tarp or cover over the faces of some of the collectors (at least half).

Covering the collectors completely is the best way to avoid overheating the fluid during a power outage.

If the solar control has to be left turned off during the day – unless it is extremely overcast – and the collectors cannot be covered, the antifreeze mixture should be drained into a clean bucket and at least one of the boiler drains left open to relieve any pressure. A typical system will hold about four or five gallons. Unplug the solar control to make sure the pump will not turn on until the system is recharged with glycol. Consult a solar professional to have the antifreeze tested and the system recharged. You do not need to drain the water storage, just the glycol.

Should maintenance be required for the hot water tank or hot water pipes, turn off the Steca control and the water heater's double (240V) circuit breaker before draining any water. This is to protect the pump and the backup electric element from damage. After water pressure is restored and the tank is full, purge air from the hot and cold lines before restoring electricity to the SolVelox and the heating element.

6. Troubleshooting

The best preparation for ensuring your system works well is for you to **become familiar with the sounds** the system makes in normal operation. Usually this is limited to a steady, barely audible hum of the pump and a slight fluid motion in the pipes

The solar storage tank is heated solely by solar input, so if it is hot the system is working. The Steca control includes a display of current tank and collector temperatures. Use the up and down arrow buttons to switch from one sensor reading to the other. By **feeling the pipes** on a sunny midday you should be able to tell a difference in the temperature of the fluid going up to the collectors and that returning. The return fluid should be warmer, although the temperature difference may be slight. And at the end of a sunny day when you have not been using a lot of water, the tank should be warm all the way to the bottom. But be mindful as you make these tests: any of these pipes can be very hot!

Another troubleshooting tool is the **pressure gauge**. Most systems will run with as little as five pounds of fluid pressure, but were probably charged

with fifteen to thirty when installed. There may be a mark on the gauge or a note written on the tank showing the original pressure. If the pressure has fallen it may be due to a pressure blow off from overheating, a dripping drain/fill valve, a punctured expansion tank, or a leak at some other fitting or in the collectors. If the pressure is low when cold but high when hot it indicates air in the lines or a faulty expansion tank. (See next paragraph.) If the gauge is near the pump you may be able to see a slight change in pressure (4-8 psi) as you switch the pump off and on. This is a good indication that the solar pump is circulating fluid.

Pressurized systems are normally very quiet; the pump hums softly, the fluid runs smoothly. A gurgling sound from the pipes or a "popcorn popping" sound from the pump indicates air in the lines. Large gushes of air should be corrected immediately, as oxygen, antifreeze, and heat combine to form corrosive organic acids that can corrode your collectors.

The **temperature sensors** are thermistors that change electrical resistance with temperature. The Steca uses 1100Ω positive coefficient sensors. The voltage to the sensors is low, so it is perfectly safe to work with them with the differential temperature control power on. Steca will show a sensor error if either sensor is open or shorted. A displayed temperature that does not match current reality is an indication of a sensor, sensor wire, or controller error.

The **pump body normally runs hot to the touch**. It should never become so hot as to discolor or blister the paint, however. If the system does not seem to be circulating heat down from the collectors (that is, pipes are not warm, tank does not get warm near the bottom) and the solar pump is hot (and possibly humming) and especially if it fails the pressure change test mentioned above, then the pump is not circulating fluid. Unplug the control and call a solar repairman. You may need to drain off some solar fluid or cover the collectors to prevent overheating until the pump is repaired.

The solar heating system is functionally independent of the backup water heating or space heating systems.

Symptom:	**Likely Causes:**
1) Pump never runs.	1a) If differential temp. control LCD screen is not lit check the outlet or circuit breaker. The Steca also has an internal fuse.
	1b) Use switch on side of the Steca; move switch from AUTO to ON (from middle to upper position). This should force the "Pumping" indicator and pump on. If the pump comes on and runs normally the problem is in a sensor, sensor wiring, or is internal to the control. Check the sensors and sensor wires first. One of the temperature sensors or wire could be open shorted, or a sensor is giving an erroneous reading. Check the Steca display for error codes or unreasonable temperature readings, or disconnect sensor wires from control and test with ohmmeter. Control literature includes temperature/ resistance charts, or call Solar Consultants to find out if reading is normal. If the sensors seem to be correct, replace the control. It is rarely feasible to repair a control.
2) Pump hums and gets hot but does not circulate fluid.	2) Pump's running capacitor or one winding is bad; rotor may be stuck. Astro pumps have removable plug through which you can access the armature to see if it is stuck. Fluid may be low (check pressure.)

3) Pump runs all the time, 24 hours a day.	3a) Test as 1b) above, but turn switch from AUTO to OFF. If pump does not stop then relay in control is stuck on. Sometimes the relay can be replaced, but most often the control must be replaced.
	3b) Opposite of 1b) above: temperature sensor/wire is shorted or sensor/wire is open, or sensor is defective. Test with ohmmeter. Control literature includes temperature/ resistance charts, or call Solar Consultants to find out if reading is normal.
4) Pump runs after sun is down, but not all night. (In very hot weather pump could run all night.)	4a) System is not effectively getting heat from the collectors into the water. The collectors stay hot, convincing the control the pump should continue to run. If, during a sunny time of day, the solar pipes near the drain/fill valves are warm or hot (feel the pipes somewhere away from the pump, NOT the pump body itself) then the solar loop **is** functioning. If they are not warm, the loop may have lost fluid (check pressure gauge), there may be too much air in the line, or the pump may not be creating circulation even though the motor may sound and feel like it is running. Any of these requires a service call to check all three possibilities. 4b) This may be the normal functioning of the "holiday" mode or over-temperature protection. (See "Description of Operation", above.)
5) System turns pump off even though the sun is still on the collectors.	5) High temperature limit of storage water (usually 100 to 130° at bottom of tank) may have been reached. If the storage tank is not hot at the bottom then this could indicate a defective temperature sensor. See 1b).
6) Noises	6a) The pump is lubricated by the water it pumps. The noise should be a steady hum. Pinging or a soft "popcorn popping" indicates air in the lines. A little of this is acceptable but large gushes are not; the system should be recharged with glycol.
	6b) Screeching or clattering indicates pump bearings are shot; unplug the control immediately.

7) Water not hot enough	Determine the events that cause this. Is it true all the time (in which case the tempering (mixing) valve, if installed, is suspect), only when there has not been much sunshine (in which case the backup heating is not sufficient), or only when you turn off the backup (in which case the solar may not be fully functioning)? If the problem seems to be the backup heat and this is provided by the electric element in the upper portion of the solar tank, the tank's over-temperature protection switch may have cut off. Shut off the 240V circuit breaker or disconnect to the water heater, open the access panel and locate the red button at the upper end of the thermostat. Push the red button and feel for a distinct click. If you feel that click, then you have reset the over-temperature protection. Reattach the cover and restore electricity to the element. After twenty minutes you should have hot water as usual. If that was the problem then most likely the solar was providing more hot water than you were using. On good solar days, that is, on days when your water heating is free and uses no outside electricity, you can use warm or hot water for things for which you normally use cold. It is also possible you have begun using more hot water than your system was designed to provide.

7. Notes Regarding Parts

• collector(s) typically SolarH2ot Platinum or Solargenix Energy Winston Series.
• water heater: any brand of water heater may be used with the SolVelox.
• solar fluid and potable water pumps: Armstrong Astro (Armstrong Pumps, Inc., 93 East Ave, North Tonawanda, NY)
• differential temperature control: Steca (dist. in US by SunEarth, Inc. (8425 Almeria Avenue, Fontana, CA 92335)
• All other parts are standard items obtainable from local plumbing supplier. If you are replacing the expansion tank make certain the new one is rated for fluid temperatures >180°F.

8. Specifications

Electrical requirements (Watts @ 115vAC) typical: 40 maximum: 100
Options:
• Thermostatic mixing valve (tempering valve) for water heater outlet.

Design changes and part substitutions may be incorporated in custom or future systems.

9. Warranty

Parts and workmanship for a complete system installed and maintained by Solar Consultants are warranted by Solar Consultants for one year from the installation date. Individual parts, especially tanks, pumps, collectors, and

controls, may be covered by additional manufacturers' warranties. Solar Consultants expands those warranties to include labor for replacement of manufacturer warranted parts.

Solar Consultants warranty is void if the system has ever been allowed to run without fluid(s) or to remain in a non-operating condition for more than thirty days.

Solar Consultants is not responsible for damage or loss of service attributable to domestic water chemistry, including but not limited to hardness, acidity, or chloramine content.

Manufacturers' Warranties (subject to change without notice)

Steca controls carry a two-year manufacturer's warranty.

Armstrong pumps are warranted for two years from date of shipment from factory.

Collectors carry a ten-year manufacturer's warranty against defects or leakage, but not against damage from freezing or outside forces. (Homeowner's insurance covers limb and storm damage.) Solar Consultants' used collectors are warranted for five years against defects or leakage.

Glossary

Ball Valve an in-line valve that controls fluid flow. They are preferable to other types in that they do not restrict flow when open and never need a washer or seal replacement.

Check Valve an in-line valve that allows fluid to pass in only one direction.

Diverter Valve or **Bypass**, a T ball valve situated to direct the solar heated water into either the cold inlet of the backup water heater ("preheat", or winter operation) or directly feed the domestic hot water line ("solar only", or summer operation).

Expansion Tank a small tank containing an air-filled bladder surrounded by fluid. As the fluid expands it compresses the air. This evens out pressure fluctuations that would be caused by temperature change.

Key Vent a bleed valve used to purge air from a pipe. It is opened with a screwdriver or square key similar to a skate key.

LED, Light-Emitting Diode an efficient and long-lasting semiconductor used as an indicator on many controls.

Pressure Relief Valve a safety valve which opens to dump fluid or water if the pressure goes beyond its set point. Sometimes the set point is adjustable; on solar loops it may be set from 30 to 125 p.s.i. On a standard water heater the PRV is combined with a temperature probe so that it can open if either pressure or temperature exceed safe limits. The outlet of the valve is sometimes piped to the drain pan, the crawl space, or outdoors.

Solar fluid The fluid consists mostly of water, mixed with an anti-corrosive buffer, propylene glycol, or ethylene glycol.

Solar loop the portion of the system that carries the fluid that passes through the collectors to be heated by the sun. This fluid is (in our systems) kept completely separate from the domestic water. Heat passes from the solar fluid to the domestic water in the heat exchanger.

Tempering Valve an automatic thermostat mounted at the hot water outlet of a water heater. If the outgoing water is above its set temperature, the valve allows cold water to mix in.

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