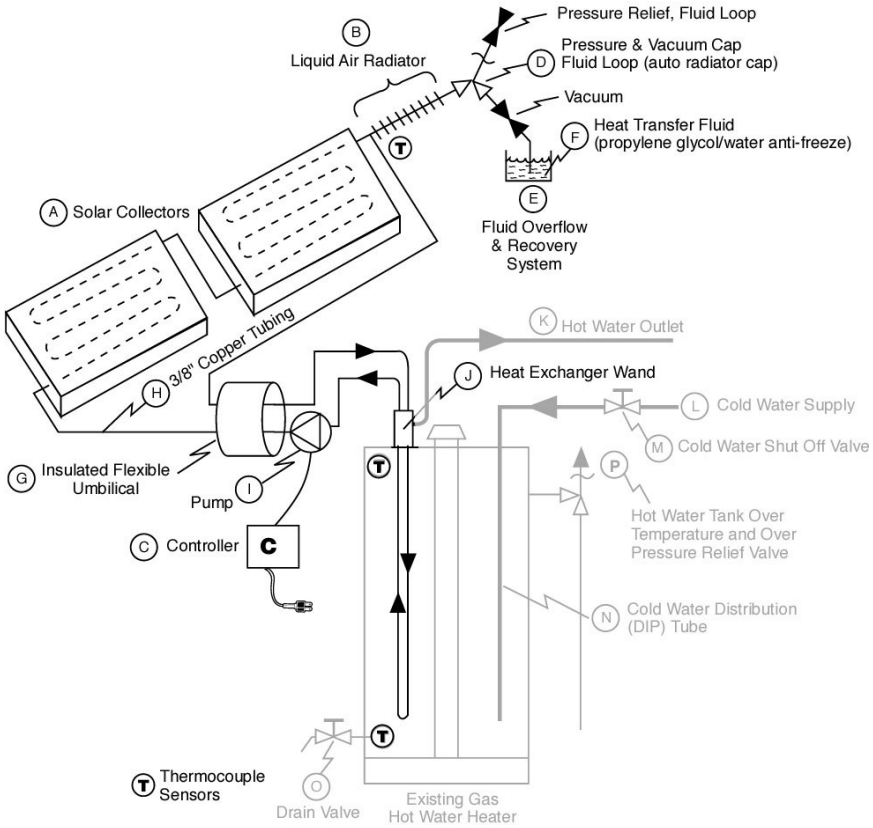
SYSTEM DESCRIPTION

FOR

THE SOLAR BUTLER 1.0
SOLAR HOT WATER SYSTEM

INTRODUCED IN
January 2003



BUTLER SUN SOLUTIONS
P.O. Box 1666, Solana Beach, CA 92075
Phone/Fax 858-259-8895
www.ButlerSunSolutions.com

1.0 System Description

1.1 System Name: Solar Butler 1.0

1.2 System Type: Low flow-rate (2 Liters per minute, 0.55 Gallons per minute) flat plate solar collector with a pressurized, antifreeze filled fluid loop and a double-walled heat exchanger immersed in the existing hot water tank.

1.3 System Description:

Glazed, serpentine, low fluid-flow, flat plate solar collector, with passive liquid-to-air radiator for stagnation protection and double walled, in-your-tank heat exchanger. The heat transfer system utilizes a pressurized, 16 PSIG, low volume antifreeze filled fluid loop, similar to automobile cooling systems. The heat transfer fluid is ASTM D5216, Propylene Glycol, commonly used in automobile radiators. Heat exchange from the collector-heated fluid to the existing hot water tank is accomplished using the screw-in solar Wand. The solar Wand is a double-walled, all-copper, in-tank heat exchanger of the American Water Works Association (AWWA) Class DWP (double wall with leak protection). The heat transfer fluid is channeled from the solar collector to the Wand heat exchanger via thin-walled, small diameter (3/8") copper tubing. The copper tubing is run side-by-side and insulated with closed cell rubber foam insulation to form a collector-to-hot-water-tank umbilical. Sensor wiring is attached to the outside of the Rubitex ^{R} insulation to allow collector temperature sensors to be connected to the controller. The circulation pump is a seal-less, low-flow, low-power, quiet centrifugal pump. The system controller uses temperature sensors on the collector and at the bottom of the hot water tank to determine when to turn on the circulation pump in the fluid loop to heat the hot water tank. If the hot water tank gets too hot, the controller turns off the circulation pump. This is a simple system using only 35 pounds of copper. Potable water sees only copper, tin-based ("lead-free") solder, and silver solder on the solar wand. The following materials contain the antifreeze heat transfer fluid: copper tubing, stainless steel in the pump, and brass fittings, making this a long-life, low-maintenance system.

1.4 Solar Collector:

Single glass glazed, serpentine flow path, selective absorber plate, thick aluminum foil-faced isocyanurate foam insulation and aluminum framed, with provision for flashing onto the roof or for mounting over the existing roof parallel or at higher than roof pitch angles.

1.5 Water Tank: Uses existing gas or electric hot water tank, select the proper collector area needed to match the existing hot water tank.

1.6 Collector Area:

1.8 m^2 (18 ft^2) for a 114 liter (30 Gallon) Water Tank
2.1 m^2 (21 ft^2) for a 151 liter (40 Gallon) Water Tank
3.2 m^2 (32 ft^2) for a 189 liter (50 Gallon) Water Tank
3.6 m^2 (36 ft^2) for a 227 liter (60 Gallon) Water Tank
4.2 m^2 (42 ft^2) for a 303 liter (80 Gallon) Water Tank

1.7 Liquid to Air Heat Exchanger:

0.61 m (2 ft. 0 in) long for a 1.8 m^2 (18 ft^2) Collector
0.75 m (2 ft. 6 in) long for a 2.1 m^2 (21 ft^2) Collector
1.00 m (3 ft. 6 in) long for a 3.6 m^2 (36 ft^2) Collector
1.22 m (4 ft. 0 in) long for a 4.2 m^2 (42 ft^2) Collector

1.8 Wand Antifreeze to Potable Water Heat Exchanger:

The Standard 1.2m (48 inch) long Wand has about 0.18 m^2 (2 square feet) of heat transfer area inside the hot water tank. The Wand has a small diameter center tube, which delivers the hot collector fluid to the bottom of the Wand, near the bottom of the hot water tank. This tube is enclosed in second tube (the first wall) and the hot fluid flow up the annular space between the inlet tube and second tube. A third tube (second wall) is spiral collapsed on the second tube, making mechanical contact for heat transfer over about 60% of the wall and leaving an air space. The third tube is vented on top of the wand, so any fluid between the second and third tubes is vented to atmosphere. This assembly is inserted in the hot water tank by being screwed into the hot water outlet port.

The wand is designed to meet the requirements of the AWWA Class DWP (double wall with leak protection). Class DWP "Provides two distinct walls which separate the transfer medium from the potable water and a path to atmosphere. Failure of either wall is indicated by visual leakage of the transfer medium or potable water and indicates a failure of the heat exchanger". The DWP type provides a higher degree of protection than the SW (Single Wall with no leak detection) or DW (Double wall with no leak detection).

The solar Wand is designed so a single failure of any fluid barrier will not cause a cross connection or permit back siphoning of heat transfer fluid into the potable water system. Any barrier, which fails, shall allow the discharge of exchanger fluid and / or potable

water to the atmosphere at a location visible to the operator or owner.

1.9 Freeze Tolerance:

Propylene Glycol-Water 50/50 -32°C (-26°F)
Propylene Glycol-Water 60/40 -48°C (-54°F)

1.10 Boiling Tolerance:

Pressurized to 16#, (16 PSIG), using an automobile radiator cap the antifreeze mixtures have the following boiling points;

Propylene Glycol-Water 50/50 124°C (256°F),
Propylene Glycol-Water 60/40 127°C (261°F).

Boiling activates the liquid-to-air radiator, which limits collector boiling by transferring solar heat from the collector to the surrounding air. Once a small amount of liquid has been expelled from the system, boiling and condensing of steam forms a heat pipe between the collector and the liquid to air radiator, limiting the temperature to the fluid boiling point listed above, since the pressure is fixed at 16#, (16 PSIG), by the pressure relief cap.

1.11 Toxicity: The recommended heat exchanger fluid Propylene Glycol-Water is non-flammable and non-toxic. Propylene Glycol is an American Water Works Association (AWAA) Class II fluid. This means that it has a Gosselin toxicity rating below 1. Class II material are considered non-potable and may be objectionable, but not dangerous to health. The normal system contains between ½ to 1 gallon of fluid. It does not need to be changed over the life of the system. Proper disposal is required. Propylene Glycol-Water mixtures are recycled by service stations and auto stores. Consult your local retailer of auto antifreeze for proper disposal in your area. Leakage or small spills can be absorbed with "kitty litter" and put in the trash.

1.12 Contamination:

The Wand heat exchanger meets the American Water Works Association, Cross Contamination Control's highest level of protection. The Wand is an anti-siphoning device. The space between the two heat exchanger wall, potable water and heat transfer fluid is at atmospheric pressure. The potable water is usually above 50 PSIG and hence will leak out of the tank. The heat transfer loop is pressurized at head above tank, usually 10 PSIG plus 16 PSIG, the cap pressure. Hence heat transfer fluid pressure would be about 26 PSIG, so fluid would leak out to atmosphere. Thus there is maximum anti-siphon protection. If the passages to atmosphere were all blocked, by accident, and both heat exchanger walls were breached, Potable water, usually greater

than 50 PSIG, would flow into the collector loop and out the pressure cap. The leak on the roof would soon be spotted and the system repaired without contamination of potable water.

1.13 Leakage: Leakage of the heat exchange fluid is not a major problem, because there is less than one gallon total. Leak can be cleaned up with absorbent towels or kitty Litter and disposed of in the trash.

Leakage of potable water would only occur at the solar Wand. There it would come out the small opening in the top of the Wand. It would then run down the side of the water tank into the drip pan or onto the floor. It would be visually detected. This would signal a bad Wand heat exchanger, which would need to be replaced. To restore hot water use until a new Wand was installed. The bad Wand should be removed and the hot water pipe reconnected to the hot water tank, just as it was before the Wand was installed. **HINT: SAVE THE ORIGINAL HOT WATER CONNECTIONS TO THE HOUSE, DO NOT DISCARD.**

1.14 Hazards: Hot pressurized heat exchanger fluid can scald and/or flash to stream, which will also scald. ((**DO NOT LOOSEN ANY CONNECTIONS WHILE THE SYSTEM IS RUNNING). (DO NOT REMOVE THE RADIATOR CAP WITH THE SYSTEM RUNNING).**

Electrical connections for the thermistors are all low voltage and protected by a fuse. The controller plugs into the wall and grounds the pump. Be sure that three wire grounded outlets are used and don't try to fix the control box. Unplug and call for service. A ground fault interrupted outlet is recommended to minimize the electrical shock hazard.

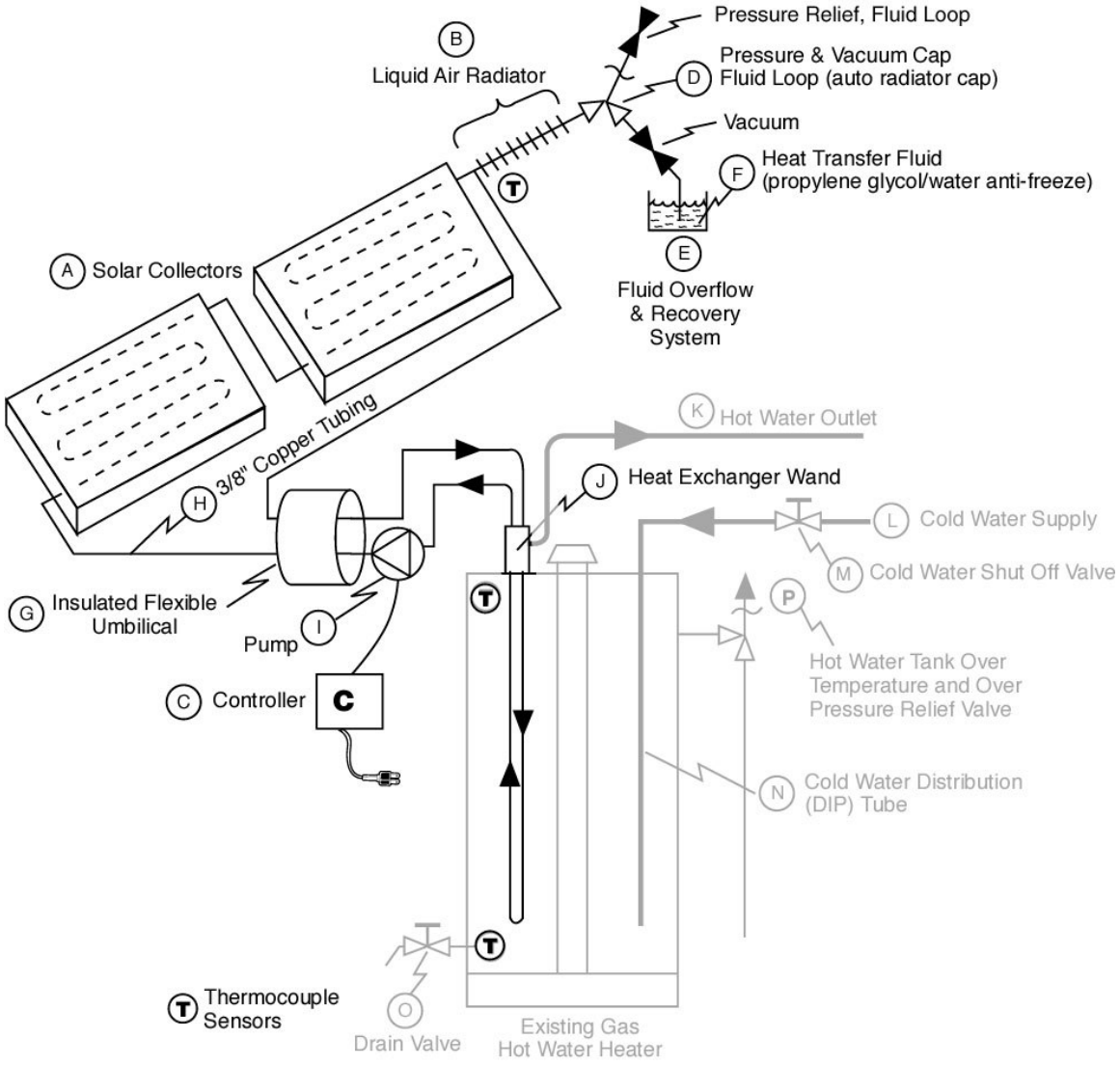


Figure 1.0.1 System Pictorial Diagram


Butler Sun Solutions
Solar Wand
Double Wall
In Tank
Heat Exchanger