Solar Hydronic System

with Drain Back Storage Tank and Optional Heat Pump

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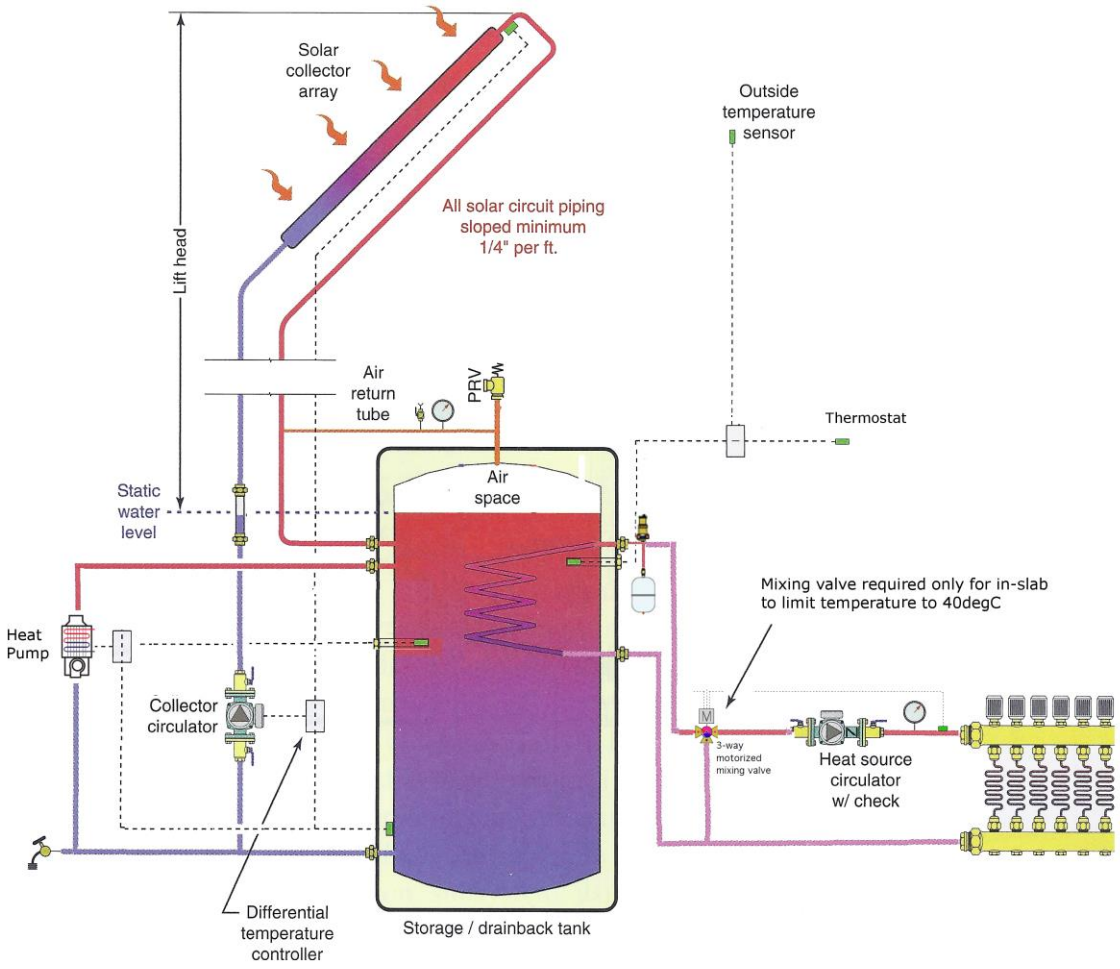
This design provides home heating, using a 1000 litre tank (or larger) to capture heat from a solar array, with a heat pump as backup. The heat from the heat pump is used to charge the tank – this way an undersized heat pump can be used (and run for longer). The design is suitable for radiators, or for inslab circuits with the provision of a 3 way mixing valve (which need water at 40). See separate designs which incorporate a gas boiler.



General Design Notes

This design maximises the efficiency of the solar loop by avoiding glycol (which introduces a 10% efficiency loss), and by avoiding a heat exchanger (which also accounts for a 10% efficiency loss).

It is suitable only for collectors that are OK for drain back – check with manufacturer. In cold regions, evacuated tubes are typically more efficient than flat panels.

Provide 250mm of straight pipe on the inlet side of pumps to maximise pump efficiency and lifetime. Pumps should be mounted as low as possible to help prevent cavitation.

Many factors may affect the performance of this design including the size of the house, the adequacy of the homes insulation, the solar gain through North facing windows, the orientation of the solar panels, and so on. No guarantees can be provided that this design will meet performance goals on every day of the year.

Solar Collectors and the Solar Loop

The solar panels should be sufficient to heat the tank by increasing the temperature in the tank by 30 degrees. It takes 35kWhr of energy to achieve that increase. 4 sets of 30-tube evacuated tube collectors can generate approximately 32kWhr in winter (in Canberra, Australia).

The controller should provide over-temperature limit set at 65 (at bottom of tank), to cut power to the pump to prevent tank water getting too hot.

Collector circulator should be a normal solar pump – ie one that will not rust, eg stainless steel.
It is better still if it is a smart pump – able to work hard to pump water up to the collectors first thing in the morning, and then to throttle back and take it easy once the return pipe is full of water and the syphon effect has established.

Site glass should be mounted at a position where water level in tank can be seen easily.
The site glass should incorporate a flow meter indication.

All solar loop piping to be in ¾ inch copper and to slope 20mm per metre back to the tank.

The return from the solar loop should enter the side of the tank below the water line to minimise noise and to help with stratification.

The air return tube should be sloped up towards the tank to prevent return water from the collectors using this pipe as a route back into the tank.

R2 insulation, as a minimum, should be provided on external pipes. The insulation should be protected from UV exposure.

Tank

A 1000 litre (or larger) tank is needed to provide enough heat storage for night-time. To a certain extent, the larger the tank, the better.

The tank should preferably be mounted inside (where the approximate 10% heat loss from the tank can be made to work for you in terms of heating the house).

It should be sealed when cold, and filled to a level approximately 160mm from the top - sufficient space to accommodate expansion of the water as it gets hotter. If the tank is not sealed, additional space should be reserved. If the tank is a different size, some calculations can be done using the method described here:
http://www.pmengineer.com/Articles/Siegenthaler/2010/10/01/The-Space-At-The-Top

A low pressure tank can be used – one that can withstand 10 PSI. By utilising a low pressure tank it is possible to get a tank built locally from stainless-steel. Sheets of stainless steel in our region come

1200 or 1500 wide, so a square tank 750 by 750 will minimise waste. A square tank is also easier to insulate. Internal supports (in stainless steel) need to be provided to stop the tank bulging.

If you use a no-pressure tank, then you cannot seal the tank – you will need to leave it open to the atmosphere. This is not a big issue – but will shorten the lifetime of your pump. Again, leave room for expansion.

Hydronic Loop

For radiators: The hydronic loop should use inhibitors eg Fernox F1 to prevent radiators rusting. With inhibitors in the water, a cast iron pump can be used, eg Grundfos Alpha 2 (sized to load).

If used, a swing check valve should be mounted horizontally (they can stick and cause hammer if mounted vertically). A swing check will valve will prevent thermosyphoning.

The expansion tank should be about 7 litres or so (for an average size system of 10 radiators or less)

An air separator should be mounted at the highest point, above the expansion tank.

For inslab heating: If you have PEX pipes in a slab with no plans to ever have a gas boiler, you can simplify the design even more by getting rid of the heat exchanger and the expansion tank, gaining efficiency in the process.

A motorised mixing valve needs to be provided as shown to limit temperature to 40degC for concrete slabs. A safety cut-out (not shown) would also be wise – to act as a precaution should the mixing valve fail.

Heat Pump

Ensure the heat pump is designed to handle oxygenated water, eg a heat pump used to heat domestic potable water is suitable.

The heat pump sensor should be mounted about half way down the tank.

The heat pump thermostat should incorporate a function (with manual override) to ensure it doesn't come on between 9am and 3pm, to maximise solar contribution. "Topping up the heat" in the tank should however be done while the ambient temperature is still high, eg late afternoon.