Apricus Tech FAQ Series

008 - Understanding Water Heating

How does solar heat the tank water?

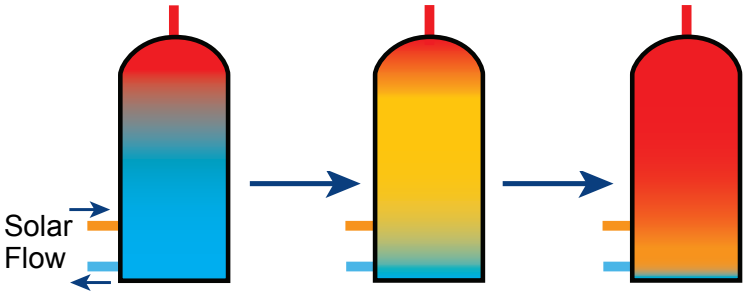

Fig 1. Solar Heating

Solar water heaters that use an active circulation format (pump) will normally heat a storage tank of water. The system can be direct flow or a closed loop utilising an internal heat exchanger in the bottom of the tank, or external heat exchanger.

Figure 1 shows how the tank is heated over time. The heat from the collector is delivered to the bottom of the tank in small "batches" of water that are around 7°C / 45°F hotter than the bottom of the tank, as per the controller settings. The collector only delivers HOT water to the tank once the bottom section of the tank has been heated to the same level as the top of the tank.

What is Stratification?

Stratification refers to the layering of water in the tank according to its temperature. Hot water rises and so will always sit at the top of the tank above cooler water. This can be see in figure 2. The top half of the tank is hot water, after for example a couple of evening showers. This water will not mix with the cold that enters the bottom of the tank if turbulence has been correctly managed by the tank design.

Stratification is important to maintain because it allow a mains pressure storage tank to deliver up to 80-90% of its volume in hot water, before suddenly turning cold. If the water mixed, the temperature would gradually drop over time which is highly undesirable when having a shower.

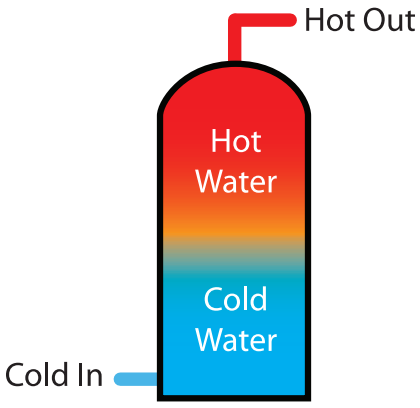

Fig 2. Stratification

Understanding Flow and Temperature

The hot water supply from the storage tank, directly or through a gas booster is normally 60°C / 140°F. In order to ensure a safe temperature at the taps, a tempering valve will reduce the temperature to around 45°C / 113°F. The water supplied to the tap is therefore a mixture of hot and cold. Additional cold may also need to be added if a cooler showering temperature is desired. A flowrate of 9L/min / 2.4gpm at the tap is NOT the same coming from the tank. Given the temperatures shown in figure 3, the tank flowrate would only be 6L/min / 1.6gpm. This should be considered when sizing a tank given a known tap usage volume.

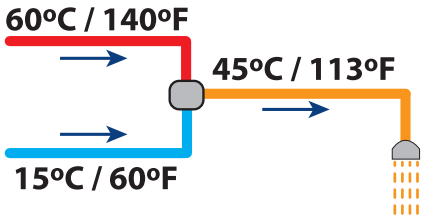

Fig 3. Temperature Mixing

Electric Boosting

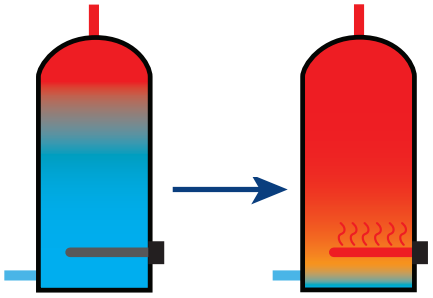

Fig 4. Electric Boosting

If there is insufficient solar contribution during the day to bring the entire contents of the tank up to 60°C / 140°F, electric boosting is required. Although a temperature of only 45°C / 113°F is enough for showering, it is a requirement in most regions that 60°C / 140°F be reached once daily to kill legionella bacteria.

Ideally the boosting should be set to come on late afternoon for 2-3 hours, to ensure sufficient hot water for evening and morning showers. Some regions have off peak heating periods during the night which will ensure a full tank of hot water for the morning. This is not ideal unless showers are in fact taken in the morning.

Gas Boosting

Boosting using a tankless gas water heater is the most efficient method as boosting only occurs when hot water is used. Because the water is stored in a tank it still needs to be heated to 60°C / 140°F to kill Legionella.

In order to ensure a safe water temperature, a tempering valve will bring the water back down to about 45°C / 113°F for delivery to the hot water taps. It may seem like a fruitless exercise to heat up and then cool down the water, but ultimately the heat is used, and so not wasted.

Only tankless water heaters designed for solar can be used in the below configuration (Eg. Takagi). A normal model will require the tempering valve to be installed before the tankless unit to reduce the water temperature to a suitable level. Refer to the manufacturers guidelines for specific details.

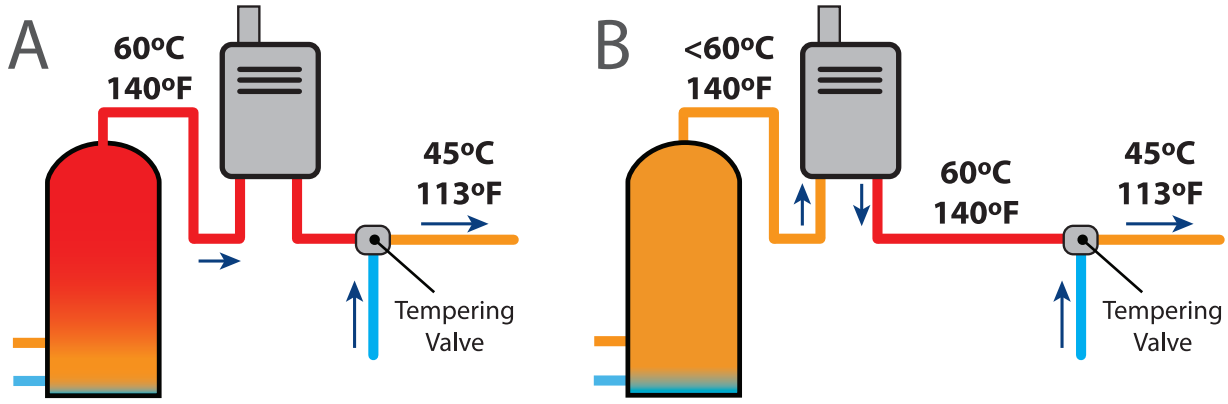

Fig 5. Gas Boosting

Solar Heating

The amount the tank temperature increases with solar input depends on how much hot water remains in the top of the tank, and therefore how much “cold” volume is available for solar heating. This is why in tank A and C (figure 7), the temperature rise is moderate, as the full tank volume is being heated.

In tanks B and D, only the bottom half is being heated and therefore the temperature rise is much greater. In tank D, the bottom is first heated to 60°C / 140°F, then the entire contents is further heated up to 75°C / 167°F, at which point the controller turns off the pump to avoid further heating of the tank.

The aim for any solar heating system should be to use all of the energy produced by the collector. Heating a tank full of cold water, as shown in A & C will result in more total heat production than for B & D, as the collector will be running cooler. Furthermore with a small volume of cold water to heat, the tank may even hit maximum temp (as shown in D), turning the pump off and potentially wasting good afternoon sunlight.

Having a dedicated solar tank is advantageous, and for this reason a gas post boost system is always preferable over an electric boosted tank system.

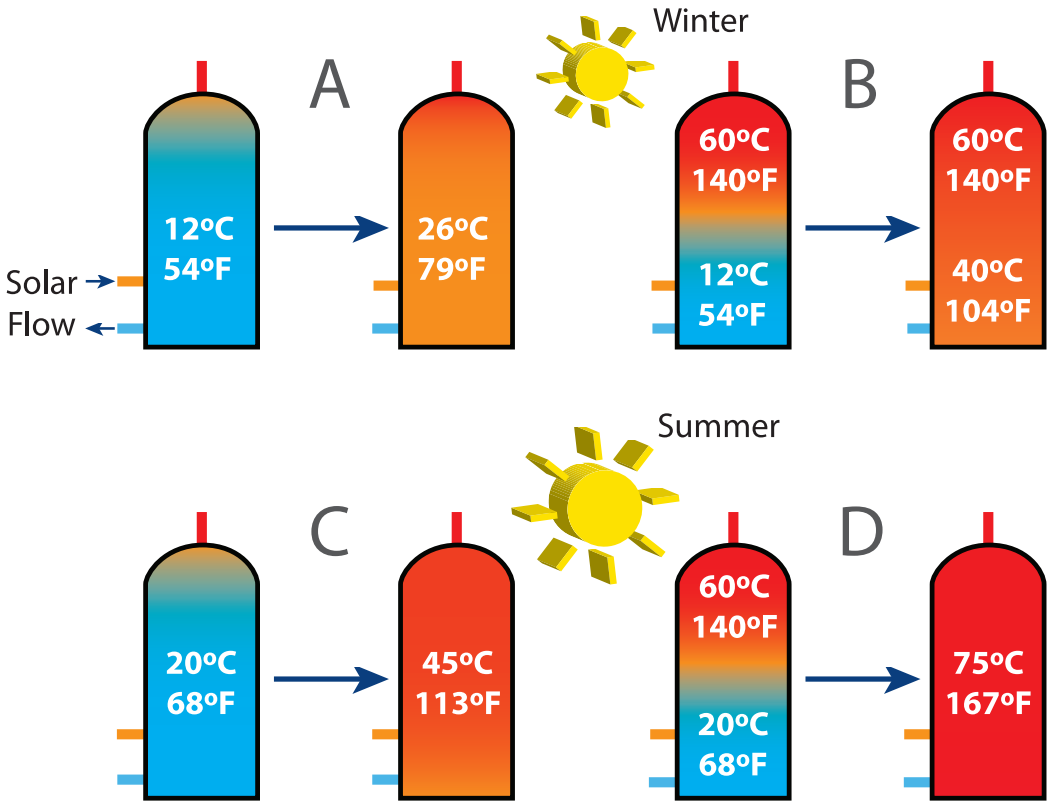

Fig 6. Solar Heating