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MARK THROWER MANAGING EDITOR

Solar thermal aids move to zero carbon

by Mark Hobbins, energy project manager, Robertson Facilities Management

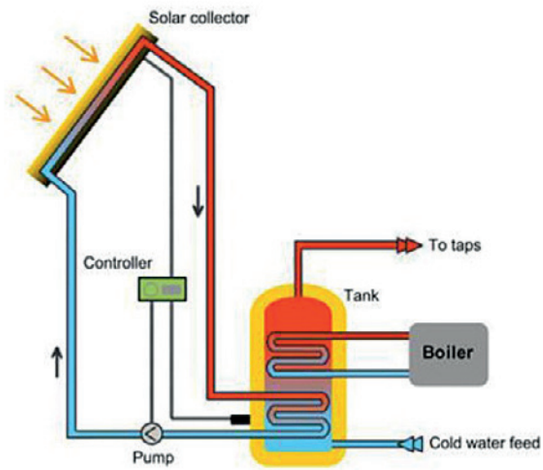
Solar thermal systems in the UK are predominately used for the provision of hot water in a domestic or commercial environment. This article provides an overview of the main items required for the successful application of utilising solar to heat hot water; and then the items to consider when thinking about a solar thermal installation. There are other applications of solar thermal like with solar air heating, Trombe walls, solar air conditioning or solar chimneys.

So why do we look to solar thermal in the first place? The main reason in recent times has been to aid meeting new building requirements for offsetting carbon emissions, as we move towards buildings with minimum or no carbon emissions. Many of you will be familiar with the aspect of Building Energy Rating and Target Energy Ratings in this area.

Similarly, the costs/benefits for retrofitting solar thermal have allowed organisations and homeowners to offset carbon while meeting acceptable financial criteria, for example a simple payback period. This has been aided in recent times with the Renewable Heat Incentive, although the value and availability of this is subject to change and uncertainty.

Of course, another reason to retrofit solar thermal is that homeowners and organisations want to be seen to be trying to reduce their carbon footprint. As awareness to renewable technologies has increased in recent years the desire to utilise these technologies has also increased.

Figure 1: A typical schematic of a solar water heating system



(Courtesy of Solar Trade Association)

Components of a solar system

So, what are the main components of a solar water heating system? Figure 1 (above) shows a typical schematic of a solar water heating system. The obvious place to start is with the solar collector. The collectors generally come in square metre panels that can be connected in series to provide a larger capacity. As a typical rule of thumb, 1m^2 will provide 35-40 litres of hot water at around 40°C. We shall come back to the temperature of the hot water produced later.

The solar collectors generally come in two forms: flat bed or evacuated tubes. So, what is the difference? Evacuated glass tubes are considered a better insulator than the insulating material used to cover a flat bed collector. Consequently, evacuated tube collectors are more efficient in colder periods. However, the flat bed collectors have greater efficiencies in warmer weather.

The higher efficiency of evacuated tube collectors means they extract more of the solar energy under lower light conditions so they are more likely to maintain their efficiency where there is considerable variation in the available solar energy.

It is never that simple though. Evacuated tube collectors have a lower absorption rate (by area) than flat bed collectors. So, it is

generally thought that in the UK both collectors have a similar performance over a year, but you would notice a difference in any one condition. So, if you are looking at a solar collector it is recommended that you consider both as well as the cost and available space for mounting. The space element is due to the surface area of flat beds being greater, which may make them more suitable in smaller available spaces. Most providers of solar thermal favour one over the other.

Figure 2 (right) shows a flat bed (left image) and evacuated tube collector (right image).

The tank in Figure 1 is called a double loop storage tank (or calorifier to give its proper name). The double loop reference is to the two different circuits: one between the collector and the tank; and, the second between the tank and the water outlets. The illustration has a third with a secondary source which will be explained when discussing temperatures.

The collector loop is a brine solution (for example glycol and water) to prevent freezing. This circuit is exposed to outside temperatures less than 4°C so would be susceptible to freezing if we just used water. This loop is also a closed loop to prevent any contamination to the hot water that is to be utilised. Even in warmer climates to our own we generally use a double loop/ circuit as it also aids balancing of the system and the tank acts as a break between them.

It should be noted that this loop is positioned at the bottom of the tank, as the solar water heating has to transfer as much of its energy to the water to be heated. This takes place at the beginning of heating of the water and the cold water is fed at the bottom (to state the obvious hot water drawn from the top where it will be at its hottest).

Encourage stratification

In general, storage tanks used in solar systems are taller and thinner than a standard hot water tank to encourage more of a stratification effect which aids the transfer from the collector. There is the option of utilising two separate tanks rather than the double loop tank, but this is often overlooked due to space requirements and costs. One tank feeds the other.

The collector pump moves the brine solution between the collector and the tank. This should be set up with the correct flow rate. It needs to overcome the head between the tank and the collector (head being the height that the brine solution needs to overcome) as well as not being too fast to prevent good heat transfer in both the collector and the tank.

The controller also monitors the system, providing the information on the various aspects of the system; for example, temperature and pump setting. The control of the system is needed to ensure the correct settings are maintained and to conserve heat in the system. Most also have an element of safety incorporated too. It is there to ensure the system operates correctly.

The main source of conserving heat is when the tank is up to temperature but not being used, the heat would transfer back to the collector loop and rise to the collector, thus cooling it. Then in turn the pump would start to then heat the tank which would then cause the system to be fighting itself. It can also prevent the secondary source from short cycling too.

Figure 1 shows a boiler attached to the system. A secondary source of heating is generally required to overcome the shortfall in temperature of the solar water heating generates at from both a

Figure 2: Flat Bed and Evacuated Tube Collector Panel

(Courtesy of Apricus)

practical use and safety.

As previously stated the rule of thumb with the temperature is around 40°C. However, it is capable of higher at times and in certain configurations. This would be a common temperature if we were to only have heat from the collector alone. However, for most domestic hot water applications we would be looking at 43°C. For a bath, shower or hand washing you would want it higher.

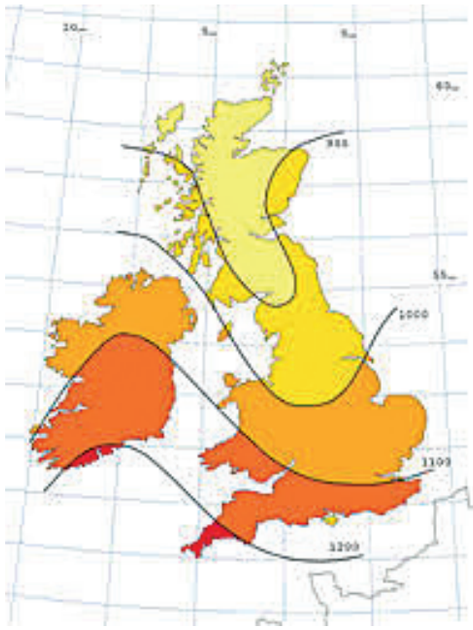
The safety aspect is that you cannot store water at those temperatures in an open loop system like we have in a domestic hot water circuit. You would leave yourself open to legionella in the system, and even more so with dead legs (dead legs being the pipe work that leads to an outlet, the obvious one being a shower head or a row of sinks in a toilet). Guidance points to having water stored in such a system at 60°C (although it needs to be above 55°C to be above the pasteurisation temperature) and with the temperature of water coming out of an outlet at 53°C in one minute (although we have to caveat that with if you have thermostatic valves at the outlet these shall likely be set to 43°C). The key message is that water needs to be stored at a temperature of around 60°C to prevent risk of legionella and that there might be some susceptibility in the temperature range of 20°C to 50°C.

Secondary treatment

In some circumstances when using solar water systems, to overcome this risk, for example in hospitals, it is not uncommon for legionella to receive secondary treatment with a UV filter system (or as an alternative to using heat to reduce the risk).

Having examined the make up of most solar thermal systems for domestic hot water, we can now look to the main items to consider when thinking about installing a system.

Figure 3 UK Solar Irradiation Annually kWh/m^2



(Courtesy of Solar Trade Association)

The most obvious would be the availability of the solar energy. In the UK this varies with location as seen in Figure 3.

Obviously, the further south and west you go the more solar energy you would likely have available. This is not the same as saying it is not worth it in the north, as you are still likely to be able to have effective systems in those regions.

Orientation and tilt should also be considered. There are two main aspects here: angle of the collector to the sun (the tilt) and the orientation to the suns path. Figure 4 illustrates how these effect the ability of the solar collector to absorb the solar energy.

As we can see from Figure 4, the optimum in most situations would be south facing and with an angle of 20-30°. Therefore, if you have a flat roof you would often see the frame they are built on at the closest angle to this. If you have a pitched roof like in many domestic houses, you would find the pitch of 25° or 40° being in the region you would wish. Consequently, the bigger of the two factors is the orientation of the panels.

Figure 4 Orientation and Tilt effect on solar collectors

ORIENTATION	WEST						SOUTH				EAST				
Tilt	90°	70°	50°	40°	30°	20°	10°	0°	-10°	-20°	-30°	-40°	-50°	-70°	-90°
0°	87%	90%	92%	92%	93%	93%	93%	93%	93%	93%	92%	92%	91%	89%	86%
10°	84%	90%	94%	95%	95%	96%	96%	97%	97%	96%	95%	94%	93%	89%	84%
20°	82%	90%	94%	96%	97%	98%	99%	99%	98%	97%	96%	95%	93%	88%	81%
30°	78%	87%	93%	96%	97%	98%	99%	100%	98%	97%	96%	95%	93%	85%	78%
40°	75%	84%	92%	94%	95%	96%	96%	96%	96%	95%	94%	92%	90%	82%	72%
50°	70%	79%	87%	90%	91%	93%	94%	94%	94%	93%	91%	88%	83%	76%	70%
60°	65%	73%	80%	83%	86%	87%	87%	87%	88%	87%	85%	82%	78%	71%	63%
80°	50%	60%	66%	68%	69%	70%	71%	72%	72%	71%	70%	67%	66%	57%	50%

(Courtesy of Which?)

In some systems, mainly small sized ones, the collectors are on tracking systems with a photometry sensor. These would move to track the suns orientation.

It is important to check that the roof can take the weight loadings of the collectors, frames and any other external items. It maybe that the roof structure can limit the amount you can place on a roof rather than area being the limiting factor. This should not be overlooked, especially in commercial systems. In addition to weight, you also need to ensure that any roof penetrations will not cause long term damage or leave the roof open to water ingress although this would purely be down to poor workmanship.

The size of the system describes the balance between the demand or requirement for hot water with the size of the collector that you can have. In an ideal system, it should be easy to achieve 40-60 per cent of the hot water demand if space allows. Once the demand is known, and the space for the collectors is known it is possible to then match up the size of the collectors to strike that balance. Then the size of the tank(s) can be calculated. This also takes into consideration the usage periods against the generation periods.

The head from the location of the tank and the collector shall then determine the size of the pump. Then it is a case of a few auxiliary items like an expansion vessel to aid in maintaining the pressure in the system; sensors to aid the control system and locating them in the correct place; and then pipework and valves.

In the UK, there is a registered installer scheme called the Micro-Generation Certification Scheme. This is a mark of quality and demonstrates an installer's ability to work to industry standards. This would be a good indication when looking to engage with a credible installer and a prerequisite to taking advantage of the Renewable Heat Incentive.

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CPD SERIES **16** | MODULE **08** | FEBRUARY **2019**

ENTRY FORM

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Please mark your answers on the sheet below by placing a cross in the box next to the correct answer. Only mark one box for each question. You may find it helpful to mark the answers in pencil first before filling in the final answers in ink. Once you have completed the answer sheet in ink, return it to the address below. Photocopies are acceptable.

QUESTIONS

1. Approximately how much water at 40°C would a 2m² solar system produce?
- ☐ 35-40 litres
- ☐ 25-30 litres
- ☐ 40-60 litres
- ☐ 70-80 litres

2. What temperature does water start to freeze at?
- ☐ 0°C
- ☐ -4°C
- ☐ 4°C
- ☐ 8°C

3. Typically how many tanks would you have in a solar thermal system?
- ☐ 1 to 3
- ☐ 1 to 2
- ☐ 2 to 3
- ☐ 5

4. To prevent risk of legionella, hot water in the system should be stored at which of the following temperatures?
- ☐ 52°C
- ☐ 25°C
- ☐ 60°C
- ☐ 43°C

5. In the UK what angle and orientation would see the best results for a solar collector?
- ☐ North facing and with an angle of 20-30°.
- ☐ South facing and with an angle of 10-20°.
- ☐ South facing and with an angle of 20-30°.
- ☐ East facing and with an angle of 20-30°.

6. Generally, a solar thermal hot water system should be able to achieve what percentage of hot water demand?
- ☐ 10-20 per cent
- ☐ 40-60 per cent
- ☐ 30-40 per cent
- ☐ 90-100 per cent

7. It is a prerequisite that solar thermal installers are certified by the Micro-Generation Certification Scheme in order to take advantage of which scheme?
- ☐ Renewable Heat Incentive
- ☐ Enhanced Capital Allowances
- ☐ Feed in Tariff
- ☐ Renewable and Household Grants

8. The collector pump carries out which of the following processes?
- ☐ Monitors the system, providing information on the various aspects of the system such as temperature.
- ☐ Moves the brine solution between the collector and the tank.
- ☐ Absorbs solar energy from the sun.
- ☐ Provides a secondary source of heating to overcome a short fall in temperature of the solar water.

9. Solar thermal water tanks are generally taller and thinner tanks to promote which effect?
- ☐ Convection
- ☐ Radiation
- ☐ Stratification
- ☐ Conduction

10. A photometry sensor can be used by a solar thermal collector to carry out which of the following processes?
- ☐ Measure the temperature of water provided to the heating system.
- ☐ Track the orientation of the sun.
- ☐ Time when the solar collector is on/ off.
- ☐ Maintain the pressure in the system.

Please complete your details below in block capitals

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Completed answers should be mailed to:

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